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SCIENCE AND THE WAR EFFORT

THE eighteenth report of the Select Committee on National Expenditure is concerned with a number of those questions relating to the scientific side of the war effort which were raised in the Select Committee's own eighth report on the organization of production, and which the new arrangements and appointments by the Minister of Production were designed to meet. The report is an acute analysis which, if it does not entirely dispel the anxieties of scientific workers, should assist to focus constructive criticism on the weak points of the present structure. It records the general impression that if the steps taken in recent months are properly followed up and the right men found to fill the key appointments, war efficiency should be improved in the vitally important matter of providing the Fighting Forces with the right weapons at the right time.

Considerations of public safety have limited the Committee to observations in general terms on the main principles of organization necessary and on specially important features in executive methods. In regard to the clarification of responsibilities, it is pointed out that the key questions are exactly where, under the new arrangements, the responsibility rests for formulating the Army's requirements and the manner in which the practical arrangements on the War Office side for formulating requirements link up with the arrangements on the Ministry of Supply side for converting these requirements into production of suitable weapons. On this it is observed that, while the answer to the first question is that the responsibility under the Secretary of State and the Chief of the Imperial General Staff is now centralized in the Deputy Chief of the Imperial General Staff, for practical purposes there must be a very clear understanding as to the nature of the responsibility carried by each of the officers, directorates or committees on which he relies.

In regard to the functional organization of research, design and production, the Committee points out that the conception of a unified functional organization requires application beyond the armoured fighting vehicles. Moreover, the Committee's realization of the vital importance of fully utilizing all available resources in the application of scientific research, technological skill and inventive intelligence to the production of improved new devices for fighting the enemy has led it to make a further inquiry into the organization on the Government side for handling the work of research, design and development. The observation that the success of new arrangements depends above all on the right men being chosen to fill the new posts as well as on the spirit in which Ministries and branches co-operate, for all its general applicability, should therefore not be taken as implying criticism of the three scientific advisers recently appointed to Mr. Lyttelton's staff to complete the organization for scientific research and development.

The main observations of this report deal with the relations between the Government organization and

manufacturing industry. While research, development and detailed designing will now, so far as possible, be carried out by parent firms in full co-operation with the Ministry of Supply, the Committee suggests that in the design of instruments of war the responsibility for checking the battle-worthiness of a design and for ordering production to go ahead must always remain entirely with the Government authorities, as well as the responsibility for giving drive and urgency to the creation of a good technical design for a defined purpose. The responsibility for creating such a design, which involves individual qualities of originality and imagination, must on the other hand be handled in close contact with those who have to carry out the task of production.

The measure of responsibility that can properly be delegated to a private firm must largely depend on its character and organization. Normally, the combined responsibility for working out a design and for taking the lead in production as the parent firm of a group should be restricted to firms of stability and proved capacity, with substantial resources and good organization. Moreover, in regard to experience and resources, such close and confidential relations must be reciprocal, and all the technical data and results be placed at the disposal of the Government; there is an implied obligation to work essentially as part of the machinery of Government rather than in the spirit of private concerns. Sometimes the exchange of information and Government assistance appear to be haphazard, particularly when contracts are distributed among a number of firms with no previous experience in the operation of the necessary processes. Certain groups seem to be left without definite leadership, and in other cases where an individual engaged on Government research work may have found means to make contact with manufacturers, the value and extent of his assistance could be greatly increased by strengthening his own staff. The Committee recommends a systematic review of the working of the existing groups, and that the continuance of contact with such groups should be made the responsibility of a special officer or officers.

Scientific workers, while somewhat re-assured by the present report, will undoubtedly await with great interest the result of the further inquiry now proceeding. Reverting to the remark made above that the success of the new arrangements for scientific guidance made by the Minister of Supply (see NATURE, September 12, p. 301) depends on the right men being chosen for the key posts, the question of the position of Sir Stafford Cripps naturally arises. With his appointment as Minister of Aircraft Production, he has to bear the responsibilities of the administration of a Department of crucial importance in the struggle. Hence it is scarcely likely that he will be able to devote detailed attention to the activities of the new scientific advisers, and since he is no longer a member of the War Cabinet, he cannot present their views to those who are directing the War. Yet one of the reasons for welcoming the appointment of the three full-time scientific advisers to the Minister of Production was the further statement that they would "work under the immediate supervision of the Lord Privy Seal [Sir Stafford Cripps]" acting on behalf of the Minister. The position is not clear at present, and will be watched by scientific workers and others with keen attention.

CIVIL DEFENCE AGAINST WAR GASES

WAR has always been horrible. Axe and sword, lance and dagger gave way to gunpowder, though it did not entirely displace cold steel even in the Crimean war; to-day we depend largely on high explosives. During the War of 1914–18 there befell a new horror—chemical warfare, the use of poison gases—which shocked the world. When peace came, the nations solemnly renounced the use of gas at a Geneva conference, a pledge which has so far been kept—nor is there any reason why it should be broken. None the less, the defence against chemical warfare has to be ready. Thus everyone in Great Britain has a gas mask and knows how to use it and care for it. In addition, a highly organized and well-trained gas service has been brought into being, ready to function when required, though hopeful that enough of civilization remains to spare the world this particular horror.

The defence against gas has the advantage over the defence against high explosive or fire bombs that it can be complete. Knowledge of what to do and the ability to do it quickly can make the individual safe in the heaviest gas attack. The value and the efficiency of the general civilian and other official types of respirator cannot be too highly rated. These respirators will stop all the likely war gases and even the strongest concentrations which can be produced in the immediate vicinity of bombs out of doors. They will remain completely effective against lesser concentrations almost indefinitely. It is the duty of men of science to make clear to their lay friends that they can have complete confidence in their respirators.

The other danger to the public is that due to splashes of vesicant gases or prolonged exposure, particularly of the eyes, to vapour from these. The area splashed by any one bomb is small, and in general the number of people likely to be splashed on its bursting will not be large. Should one become a casualty, the skin must be treated without delay with the ointment which has been prescribed for the purpose. In addition, should gas be used, chemists' shops will have pails of bleach cream ready for use by persons who may not have ointment immediately available. The clothing must be shed at once so as to prevent penetration of liquid and vapour to the skin. The Ministry of Health has made ample arrangements both for personal cleansing and for decontamination of clothing. Above all, it is important to keep the eyes shielded should a gas attack be feared.

The vapour danger from vesicant gases, which exists until the liquid in the streets has been destroyed, depends upon the concentration and the time of exposure. This danger is therefore also a function of temperature, which governs the concentration, and so is less at night. Under ordinary conditions the time required to produce blistering effects on the skin may be as much as an hour or more. There is, therefore, no need to run this risk by remaining so long in the vapour. Vesicant burns are highly undesirable wounds, but they can be largely avoided by the exercise of commonsense.

No branch of the national defence has been more fully or precisely documented than gas. The Government has enlisted the help of some of the ablest scientific men of the country to aid the official chemical defence organization in the preparation of a series of A.R.P. handbooks. These were ready from 1936 onwards and have, where necessary, been kept up to date by new editions. The information given in these represents the considered conclusions of many who have thoroughly studied the subject in a practical manner; the handbooks are cheap, and they form the basis of the instruction given to an increasing number of pupils in the A.R.P. training schools. Numerous books on the subject have also been published; at the best these are but copies in altered wording of the official handbooks and, where in them an author chooses to air his own views, he runs the risk of being at variance with those who have been in a position to make experiments.

A gas attack may have several consequences: it may injure the individual or contaminate his clothing and surroundings, or it may contaminate foodstuffs, rendering them unfit to eat. This last aspect is a special one, and in view of its importance and the need to prevent any waste of food, it has received full official appreciation and study. The problem involves recognition that a foodstuff may have been contaminated, a task performed by the Gas Identification Service; the determination of the degree and extent of the damage by the analyst; and the decision whether the material must be destroyed or can be decontaminated and made fit for consumption.

It is necessary and proper to create and train an organization ready to cope with gas-contaminated foodstuffs, however great the emergency. There is a tendency, however, in certain quarters to exaggerate this danger. It is highly unlikely that gases or vapours themselves will harm most foodstuffs, and since the majority of foods are stored inside buildings and are themselves in packages, splashing or liquid contamination is not likely to be a frequent occurrence. It is arsenical contamination which gives most cause for precautionary measures. It is possible that gas bombs may fall in water reservoirs. Such incidents have to be studied from the point of view of the volume of the reservoir in relation to the volume of the bomb, and may be regarded in general as of small significance in making water unpotable.

It is sometimes overlooked that any gas brought to Great Britain from a foreign country has to be carried in aeroplanes, which are limited in numbers and have a restricted load. Calculations which can readily be made indicate that the maximum possible amount of gas that can be dropped in a given time is very small in relation to the total volume of air over, and total extent of ground-space in, the area attacked. Hence its effect may be expected to be local rather than general, and limited in magnitude. There can be no such thing as a lake of gas persisting over a large area, or a whole city soaked in gas.

To-day the ordinary citizen has a good deal to think about and it may be unfair to expect that, while he regards the use of gas as improbable, he will take a keen interest in his personal defence against gas. There must be no slackening, however, in the effort to train the A.R.P. key men in gas defence, for it cannot be too strongly emphasized that a highly perfected defence against gas is the best means of ensuring that poison gas will not be used against our cities, since such an attack can then have little success. It is obviously impossible to do more than express the view that this work is being well done.

The problems confronting the authorities during and after a raid in any 'target area' are likely to be many and varied. It is to be supposed, for example, that gas bombs will be mixed indiscriminately with high explosive and incendiary bombs. The available resources, growing more scanty as the need for men for the Armed Forces gets more pressing, will have to be deployed to the best advantage, while those in the control rooms will need to be able to appreciate the significance of any happening and to take measures to allay panic and meet the situation. Gas being a weapon, unknown and unseen, may well cause panic unless men with the qualifications of the gas advisers and gas identification officers are available in the control centres and able to reduce the imaginary to the actual danger. The task of such officers is to correlate the mass of evidence from incoming reports, advise in regard to contradictions and anomalies, and generally keep the incident on a sane and sober basis.

The planning of exercises on a large scale is an important part of the training of the senio officers. All the different units concerned learn to know one another and to work together. Such exercises go beyond the actual attack by gas on the people and their homes; they comprise also the rescue of contaminated food, the making safe of streets splashed with mustard gas—an operation which can now be done in relatively few minutes—and the decontamination of the individual room in a house which has received a direct hit.

By such training and preparation, which are part of the normal experience of the Armed Forces, the civil population can be guarded against the effects, subjective as well as objective, of gas attack. Given effective protection, as scientific men will readily appreciate, gas attack can achieve little success; the knowledge that an adequate defence service against gas is in operation will be a major factor in deterring the enemy from using it.

MATRILINY IN INDIAN SOCIETY

Mother-right in India

By Baron Omar Rolf Ehrenfels. (Osmania University Series.) Pp. xi+229. (London: Oxford University Press, 1941.) 12*s.* 6*d.* net.

BARON EHRENFELS has undertaken an ambitious scheme in his analysis of mother-right in India, and that is no less than to investigate "the entire complex of problems grouped round the questions of the matriarchal system in India". The results at which he arrives are far-reaching. He concludes that in the south-west, if not in the main peninsula, of India there have been four strata of matrilineal peoples, while a fifth is to be found in the north-east. A map indicates the distribution all over India of more or less isolated features of these matrilineal cultures, which survive as complete and functioning matrilineal societies only on the Malabar coast in the south-west, and in the Khasia and Garo Hills in the north-east. To the influence of these matrilineal cultures of the past, of which traces only now survive in the greater part of India, Baron Ehrenfels attributes a very large number of past and present features of Indian society. Thus the efflorescence of Buddhist culture in the fifth, fourth and third centuries B.C., the practice of vegetarianism, the widespread, if socially despised, institution of the matrilocal marriage in which the son-in-law goes to live as a *ghar-jamai* in the house of his sonless father-in-law, and many familiar features of Rajput society past and present, such as the practice of *johar*, that is, the immolation of themselves by the women *en masse* when their men were defeated in warfare, and the continuing use of cattle in marriage processions, are all put down to the influence of the fourth matrilineal culture, which is held to have flourished at Mohenjodaro, while megalithic cultures, head-hunting, and the practice of sacrifice by decapitation, for example, are ascribed to an earlier and more primitive stratum of matriliny. Other institutions again, child-marriage, hypergamy, bride-prices, are directly ascribed to the clash of immigrant patrilineal with pre-established matrilineal cultures, while totemism is regarded as the pure product of a patrilineal age.

It can scarcely be said that the author makes an entirely convincing case for all this. Wide as his research has been, the very nature of the evidence is such that its interpretation can only rest on inference, and alternative hypotheses cannot be excluded. For one thing Baron Ehrenfels belongs emphatically to the *Kulturkreise* school of Schmidt and Graebner; Father Koppers, indeed, has written a preface to his volume. Not everyone will be willing to attach the same importance as that school attaches to migrations of peoples as the agents in spreading cultures, for it is easy to show that ideas, languages and social customs can be diffused no less widely than material culture without any movement of population. In any case an attempt to deal with Indian cultures on such lines ought not to have ignored, as Ehrenfels has done, the significant distribution of brachycephaly in India; and one may legitimately take exception to the use of the terms 'Aryan' and 'Dravidian', which are purely linguistic terms, as if they had a satisfactory racial significance. The essential continuity of traditional and popular Hinduism with the pre-Rigvedic religion of India has not been appreciated. This religion conquered that of the Rigvedic invaders and reduced their high god, Indra, to a mere doorkeeper. Thus the Black Yajurveda prescribes the sacrifice of cattle to a number of Rigvedic deities, but not to Shiva, whose cult goes back to the Indus civilization; later the Aditya Purana prohibits the sacrifice of cattle "because certain noble and wise men did not practise it", while a later authority still states that although their flesh may fitly be offered to Mitra and Varuna they should not be sacrificed, because the public detested it. Marshall's arbitrary distinction between the bull cult of Mohenjodaro and a cow cult ascribed to the 'Aryan' invaders has, of course, no sort of validity, and should not have been accepted. Ehrenfels follows Heine-Geldern in identifying the short-horned bull on the Indus seals with the gaur, an identification the reviewer is inclined to accept, but it must be pointed out that both Friedrichs and Olver identify it with either *Bos primigenius* or *Bos namadicus*, Olver specifically rejecting any identification with *Bos gaurus*. There are some regrettable omissions in the material surveyed. The people of the Simla hills, and the Khasas and Hill Doms of the United Provinces, with their many survivals of matriliny and of the worship of snakes and a mother goddess do not appear at all, nor do a number of the Assam tribes, the Lakher in particular, which retain striking survivals from matrilineal cultures.

Whatever its defects, however, "Mother-right in India" is a work of much importance to Indologists, particularly in its suggestive ascriptions of so many features of Indian culture to a clash between an established and more or less civilized matrilineal society and an invading patrilineal one. In this respect Baron Ehrenfels has hit on an important and even fundamental element in the construction of Indian society as we know it now. The reviewer has himself suggested that the social grading of castes in the Laws of Manu has a similar origin. The offspring of a Brahman man and a woman of lower status may stand socially near the top of the list; that of a Brahman woman by a man of low caste comes at the very bottom. It seems likely that this scheme is the formalist interpretation at a later date of the conditions and traditions surviving from a time when the issue of a marriage between a patrilineal man and a matrilineal woman inherited status, if not property, from both sides, whereas the offspring of a patrilineal woman by a matrilineal man would have neither status nor inheritance on either side. The Brahman doctrine that the woman is a mere soil for the reception and nourishment of the seed of the man, to which she contributes nothing essential of her own, is the sort of simple and plausible idea that might easily appear to be the sudden revelation of a profound truth among uncritical peoples observing matrilineal customs without perhaps laying any particularly marked emphasis on the part played by the male in procreation, and one can imagine the spread of such an idea with devastatingly revolutionary effects on culture. It is perhaps rather to some phenomenon of this kind that we should look for an explanation of the inconsistencies of Indian culture patterns than to an application of the culture-strata theory of the Vienna school. But the material for study remains constant and much of it has been collected and collated for us by Baron Ehrenfels.

J. H. HUTTON.

MATERIALS FOR STUDENTS AND DESIGNERS

Strength of Materials

By Prof. S. Timoshenko. Second edition. Part 1: Elementary Theory and Problems. Pp. xiii+359. Part 2: Advanced Theory and Problems. Pp. xiii+510. (London: Macmillan and Co., Ltd., 1940–1941.) 2 vols., 50*s*. net.

IN 1938 a remarkable tribute was paid to Prof. Timoshenko on the occasion of his sixtieth birthday. Advantage was taken at the annual dinner of the American Society of Mechanical Engineers to honour him by a programme of appreciative speeches and to present to him a commemorative volume in which original articles, dealing with various aspects of the mechanics of solids, had been contributed by engineering and scientific friends each with an international reputation. It is not surprising, therefore, that text-books from Prof. Timoshenko should be welcomed by all interested in the progress of engineering learning.

The present review deals with the second edition of his now famous work on the strength of materials. This is divided into two volumes, the first of which is devoted very largely to the presentation of matter usually taught in engineering degree courses dealing with the strength of materials. For post-graduate students and research workers the second volume will be found particularly suitable, since it deals with those difficult features of engineering design and investigation which all engaged in engineering production must, at some time, inevitably encounter.

Although no great changes have been made in this second edition, yet where experience has shown that teaching requirements may be better met, modifications in the methods of presentation have been adopted and some of the more advanced work, originally contained in Part 1, has now been transferred to Part 2. In place of this advanced matter, a more extended treatment has been given in Part 1 to some of the problems previously expounded rather briefly, with the result that the student will now read these with greater understanding.

Space will permit of only a brief reference to the contents of these volumes, but some attention may be given to a few features. Thus the admirable arrangement of Chapter 1, dealing with tension and compression within the elastic limit, can be especially commended. Here the student is gradually led from the most elementary consideration of stress and strain up to the solution of quite difficult problems by a skilful blending of descriptive matter and excellent examples. In like manner, the method of dealing with the deflection of loaded beams calls for admiration. Commencing with the equation of the deflection curve, the usual integration method of determining deflection of cantilever and simply supported beams with different types of loading is first employed, and here again the arithmetical examples provided are particularly suitable. This is followed by illustration of the use of the bending moment diagram and the method of superposition, whereby the solution of difficult problems under complicated systems of loading and different methods of support can easily be effected. Later on, the elastic strain energy method is given and attention directed to considerations of the effect of shear. In all this fundamental work, the manner in which the student is conducted from the simple to the more complicated problem is a great tribute to the powers of Prof. Timoshenko as a teacher.

In Part 2, special attention is given to the later developments, both theoretical and experimental, of practical importance in the fields of strength of materials and theory of elasticity. Problems connected with aeroplane construction are considered under the investigations into the bending, compression and torsion of slender and thin-walled structures. A chapter is devoted to plastic deformation and another to experimental investigations on the behaviour of materials at high temperatures and to fatigue under conditions of stress reversal.

Although for much of the work in this volume a fairly high standard of mathematics is required, yet the author never omits to place the practical engineering considerations before the reader, and continual references are made to original papers on the subject under discussion. Thus, following the mathematical treatment of stresses produced by shrink fits, attention is directed to special articles dealing with experimental investigations into this class of engineering construction. It is suggested here that some mention might have been made of the work of Russell, who showed experimentally that the effectiveness of the shrink fit largely depends upon the surface cleanliness of the two mating elements.

One difficulty to British students will arise from the author's use of symbols which differ appreciably from those employed in our own text-books. In this second edition, changes have been made in the notation to conform with the requirements recently adopted by the American Society of Mechanical Engineers. It is to be hoped that it will not be long before a standard list of symbols will be drawn up which will be common to both countries.

WEATHER STUDY

Weather Study

By Prof. David Brunt. (Nelson's Aeroscience Manuals.) Pp. 216. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1942.) 5*s*. net.

WAR has always been very much at the mercy of the weather, and the advent of flying emphasized the dependence. Between 1914 and 1917, meteorology gradually came to be an essential part of the fighting organization, though the scientific side of the work was still in the hands of a relatively few professionals. In the present conflict some knowledge of the subject is essential, or at least helpful, to a large number of 'other ranks', while the number of civilians engaged on work in which the physical processes of weather are directly or indirectly involved must run into thousands in Great Britain alone. These men and women, mostly young and intelligent but with little specialized training, are eager to learn; yet the range of suitable text-books open to them is sadly limited. Hence Prof. Brunt's new semi-popular book, written explicitly for this class of reader—he mentions in particular Air Force Cadets and students of radio-location—is very welcome.

The emphasis on weather study has shifted very definitely from the descriptive to the analytical side, and especially to the physics of weather. The early meteorologists were for the most part content to

explore and describe the facts in terms of averages and extremes of temperature, rainfall, etc.; the moderns seek to explain them in terms of air-masses, fronts and lapse-rates. But the physical meteorologist requires more rather than fewer observations, and the first requisite for the young meteorologist is a thorough knowledge of the instruments and methods of observation. This is the subject of Chapter I, which might usefully have been twice the length. For example, although the units of pressure and temperature, and the various corrections to the barometer reading, are set out in some detail, the vernier is barely mentioned, and the reader is not warned at all against such errors as parallax. It would have been better to have given a definite reference in the text to the "Meteorological Observer's Handbook" rather than to leave it to the appendix, and for less ambitious readers, mention might be made of "Hints to Meteorological Observers". One cannot but feel that Prof. Brunt is not really interested in such mundane details, but is anxious to get on with the meteorology.

The rest of the book on the whole meets the criterion "not too little, not too much" very well. In Chapter 2 the author plunges boldly into what is probably the most general immediate cause of most weather phenomena, the diurnal variation of air temperature near the ground and its variation with height, with the corresponding phenomena of inversions and super-adiabatic lapse-rates, though adiabatic changes are not actually explained until a later chapter. Then follows a very brief account of world climatology, in which *causes* take wise precedence, the more striking facts only being used as examples (incidentally, the statement that in India the monsoon rainfall amounts "in places at times to several hundred inches within one month" might give an exaggerated impression; the two recorded instances of falls exceeding 300 in. in a month are both doubtful).

The core of the book is reached in the chapters dealing with the elementary physics of the atmosphere, including adiabatic changes of dry and saturated air, conditions in the upper air as represented by tephigrams and similar diagrams, the effects of radiation, and water vapour in the atmosphere. The remaining chapters consist of an introduction to the study of synoptic charts, decoding and plotting the observations, drawing the isobars and interpreting the charts in terms of gradient and upper winds and air masses. Depressions, both frontal and non-frontal, are described in some detail, but the account of thunderstorms is meagre; considering that the book is specifically dedicated to, among others, students of radio-location, one would have expected to find some reference to atmospherics, and even to the ionosphere.

On the whole, the book fulfils its purpose admirably. Though mildly mathematical in places, it is rarely difficult, and the more abstruse sections are well provided with clear diagrams. There are inevitably some blemishes; for example, the odd breaks in the diagram of relative humidity in relation to dry- and wet-bulb readings should have been explained as due to the coating of the wet-bulb with ice, and in the equations of change of pressure with height some confusion is caused by using d for the differential and for density in the same equation. Later, a curve stated to be the barograph curve of a sailplane flight is described as "rising or falling as the aircraft met rising or descending currents". These are minor points; more serious is the fact that the map of prevailing winds in July has suffered some sea-change and is about as wrong as it could be, showing, for example, sweeping *easterly* winds in the temperate latitudes of the southern hemisphere.

It is most unfortunate that lack of attention to detail and proof-reading should have marred what is in most respects an excellent book, for any reader who has dealt with it faithfully and written out answers to the test questions at the end of each chapter may fairly consider himself on the way to becoming a proficient meteorologist.

C. E. P. BROOKS.

THE FALLING BIRTH-RATE

Parents Revolt

A Study of the Declining Birth-rate in Acquisitive Societies. By Richard and Kathleen Titmuss. Pp. 128. (London: Martin Secker and Warburg, Ltd., 1942.) 3*s*. 6*d*. net.

THIS book, which comes with a commendatory foreword by Beatrice Webb, is the work of writers well versed in the comparatively new but vigorous science of demography. As its title clearly intimates, however, its aim is not academic but practical. Demography has made rapid progress since the War of 1914–18. Its new and exciting discoveries, say the writers, though of vast importance to the future of man, are practically unknown to the general public. What the general public does know is that the practice of birth control, by means of devices for preventing conception, has spread from the well-to-do classes, among whom it arose in the closing decades of the nineteenth century, to the wage-earners. Long periods of unemployment and under-employment have been chiefly instrumental in causing the wage-earners to follow the example of their 'betters'. The authors give facts enough to show that we are now "between two biological worlds: one, the Age of Expanding Numbers, is dead; the other, the Age of Contracting Numbers, is just commencing". We are entering upon an unknown and a perilous period of our history. If, they affirm, the working people of Great Britain had during the past forty years returned the same birth-rate as the well-to-do, we should not have had sufficient man-power to wage the War—and money would not have saved us. Should it be objected that there is an element of guesswork in this statement, there is at any rate none in the next, which relates to the number of children in the school-group 5 to 14. In 1913 the number was upwards of seven millions, in 1938 only six millions. Assuming that the same conditions prevail, Dr. Enid Charles estimates the number as about four millions in 1950, and three millions in 1960. The authors refute in the strongest possible terms the suggestion that the falling birth-rate is due to the selfishness of parents, but their condemnation falls very heavily upon an economic system in which children seem to be simply not wanted. They recite an impressive array of facts to prove their point.

The authors' hope for a future which they aver is not necessarily gloomy lies in getting people to share Abraham Lincoln's belief in a time coming when "Money will cease to be master and become the servant of humanity". They point out that modern sanitation, social services, factory reforms and State education passed muster, not so much because they were right as because they would "pay"; and that

proposals for public works in relief of unemployment were argued only in terms of finance. They gibbet the May Report of 1931 which decided, for example, that Britain could not afford £1½ million a year for extended services to reduce maternal mortality—a sum we now spend in three hours of war.

This book is designed to help the common man to face the fact of revolution in reproduction, for in the long run, as the authors affirm in their final chapter, "The People Must Decide".

SCIENCE IN SOVIET RUSSIA

Science in Soviet Russia

By Seven British Scientists. Edited by Dr. Joseph Needham and Jane Sykes Davies. Pp. v+65. (London: Watts and Co., Ltd., 1942.) 1*s.* 3*d.* net.

THIS little book provides a most useful glimpse of some of the scientific developments which have contributed towards the prodigious effort of defence by the Soviet Union in the present War.

The strength of science in the U.S.S.R. is based on its position in the official ideology. It is believed that a correct outlook on life and an adequate standard of living involves science as an integral part of all activities, spiritual and temporal. Hence science has been connected with every aspect of life, and its position in the Soviet State might be compared with that of the nervous system in man. As a result of these ideas, immense sums have been spent on laboratories and the training of scientific workers, and developments have been made according to plans. The scientific part of the new social order is in the main only fifteen to twenty years old. It has produced tens of thousands of new young scientific workers, many of them somewhat raw and not yet old enough in tradition to have highly developed scientific intuitions and critical judgments, but superb material for flying and artillery officers and factory management.

The events of the War have driven the chief Allied nations to create scientific organizations which grow more and more similar to the Soviet system of planned science. For this reason, as well as the bare facts, the seven essays in this book are of interest. Dr. Shoenberg's essay on physical research in the Soviet Union is outstanding. He speaks Russian, and has had the opportunity of working in Prof. P. Kapitza's laboratories in both Cambridge and Moscow. His comparative study of the two experiences is most illuminating. He says that the Moscow institute is several times larger, and has pleasant grounds. It has a staff of sixty people, compared with ten in the Mond Laboratory. For each physicist in the Soviet laboratory there are ten other employees, while at Cambridge there is only one. Half of the sixty are janitors, charwomen, chauffeurs, boilermen, gardeners, etc. Ten are office workers, and there was a good deal of 'red tape'. The ratio of mechanics and technicians to physicists was about four times as great as in England. Dr. Shoenberg found this a real boon. They were first-rate craftsmen, and so released much more of the physicist's time for attention to real physical problems.

Another attractive feature is that the research worker belongs to a particularly respected profession, and is not liable, as in pre-war England, to be asked: "But what do you do for a living?"

Dr. Ruhemann writes on industrial research from his six years' experience at Kharkov, Dr. Needham reviews work in biology, Dr. Walton agricultural research, Mr. Roscoe Clarke developments in medicine, and Dr. G. W. Tyrrell the growth of geology and mineralogy.

It is all informative, and is very reasonably priced.

J. G. CROWTHER.

LINEAR DIFFERENTIAL EQUATIONS

Operational Methods in Applied Mathematics

By Prof. H. S. Carslaw and J. C. Jaeger. Pp. xvi+264. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 17*s.* 6*d.* net.

A WAY to solve linear differential equations by operational methods which avoid the introduction of arbitrary constants by taking direct account of the initial conditions was invented by Oliver Heaviside (1850–1925) for the purpose of discussing electromagnetic waves. In his hands the method led to correct results, but the mathematical foundation was so obscure as to cause it to be regarded with misgiving. Bromwich (1875–1930) was the first to explain Heaviside's method, and, by expressing the solution in the form of a contour integral, to justify its application to ordinary linear equations. Since then many systems, modifications and expositions of varying degrees of merit have appeared.

The present work is based on the application of the Laplace transform

$$\bar{x}(p) = \int_0^\infty e^{-pt} x\,dt,$$

where p is a positive number sufficiently large to ensure the convergence of the integral and x is a given function of t. Thus, if $x = e^{at}$, $\bar{x}(p) = 1/(p-a)$. To take a very simple illustration, consider the equation $dx/dt + 3x = e^{-2t}$, given that $x = 0$ when $t = 0$. Multiply by e^{-pt} and integrate from 0 to ∞. This gives:

$$\bar{x}(p) = \int_0^\infty e^{-pt} x\,dt = \frac{1}{p+2} - \frac{1}{p+3},$$

so that $x = e^{-2t} - e^{-3t}$.

It will be seen from the above that the solution is inferred by writing down the function x whose Laplace transform is given, that is, by inverting the transform. In simple cases this can be done by inspecting a list or dictionary of transforms (such a list is given at the end of the book). When inspection fails, the inversion can be effected by a general theorem which expresses x as a contour integral when $\bar{x}(p)$ is given. Thus the method is direct, simple to apply and easy to understand.

The book contains three purely mathematical chapters on the application of the Laplace transform to linear equations with constant coefficients, on the inversion theorem, and on linear partial differential equations. The remaining seven chapters, each complete in itself, discuss a varied and interesting collection of problems in electric circuit theory, dynamics, conduction of heat, vibrations of continuous systems, hydrodynamics, electric transmission lines, electric waves. There are also numerous exercises for the student.

The book is well written, well printed, and can be recommended unreservedly to all who have to make scientific applications of linear differential equations.

L. M. MILNE-THOMSON.

MEASUREMENT OF ELECTRONIC CHARGE

By PROF. T. H. LABY, F.R.S.
University of Melbourne

Oil Drop Method

THE steps in the progress towards precision in the measurement of the electronic charge, e, are well known. The first measurements by J. S. Townsend and J. J. Thomson of 1897 and 1898 were approximate ones. H. A. Wilson in 1903 used a method new in principle, but it was not until Millikan and his many co-workers had completed their comprehensive investigations of the oil drop method and the viscosity of air that e became known with precision.

Observers	$e_0 \times 10^{10}$	$m \times 10^5$
Authors	4·802 0 ± 0·001 3	0·037 7$_1$ ± 0·000 4
Millikan	4·799 2 ± 0·003 7	0·037 8$_4$ ± 0·000 1
Bäcklin and Flemberg	4·781 1 ± 0·018	0·037 2 ± 0·001 4
Ishida *et al.*	4·835 0	0·036 1

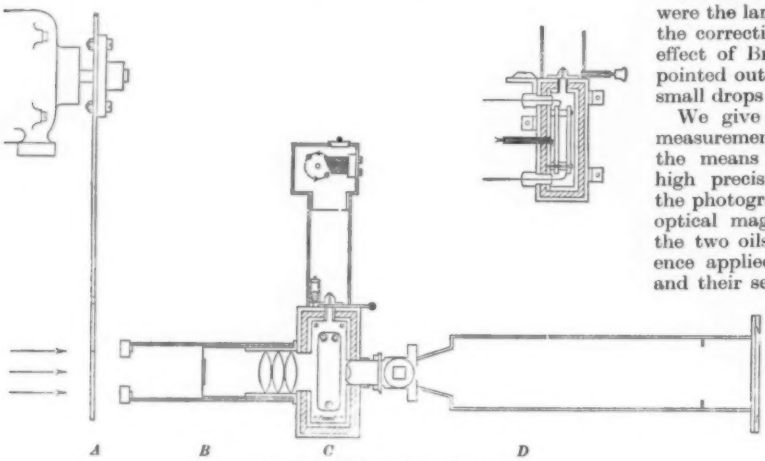

Fig. 1.* SKETCH OF APPARATUS.

A, rotating disk, which allows intermittent entry of light into the optical system.
B, optical system arranged to produce dark-ground illumination.
C, deflecting plates in central chamber arranged vertically so that drops are horizontally deflected by the electric field.
D, camera for photographing image of drops.
Brush for producing oil drops of suitable size is at the top of chamber shown vertically above condenser plates. On the right is a side-view of condenser plates.

*Figs. 1 and 2 are from a paper by V. D. Hopper and T. H. Laby in *Proc. Roy. Soc.*, A, 178.

Millikan's final value was accepted for a number of years without, if not as beyond, criticism until measurements by the X-ray method gave values as high as $4{\cdot}805 \times 10^{-10}$ E.S.U. for the electronic charge; this was greater than his value, $4{\cdot}774 \times 10^{-10}$ E.S.U., by many times the estimated probable errors of both. Some writers then raised the question whether the drop method was comparable in precision with the X-ray one.

There are several other methods of measuring e, as for example the α-ray one, but apparently none of them are precision ones.

Mr. V. D. Hopper and I [1] have determined e by means of a modified oil drop method, similar to H. A. Wilson's, but differing from it in that the electric field acts in a horizontal direction and not vertically. The drop describes vertical and inclined straight line paths.

The expression giving the uncorrected electronic charge, e_1, is

$$Xne_1 = 9\sqrt{2}\pi\eta^{3/2}(\rho-\sigma)^{-\frac{1}{2}}g^{-\frac{1}{2}}v_g^{\frac{1}{2}}v_x,$$

where n is integral, v_g is the free fall and v_x is the velocity of the drop in the direction of the electric field X. The relation

$$e_1^{2/3} = e_0^{2/3} + m/pa$$

corrects e_1 for departure from Stokes's law, where a cm. is the radius of the drop, and p cm. of mercury is the air pressure. The oil drops were photographed (at intervals of 1/25 sec. using a 1/1,500 sec. exposure) to eliminate subjective timing errors, and disturbing effects of the light beam.

We used large drops (eight of them were the largest so far used) to decrease the correction to Stokes's law, and the effect of Brownian motion. As Perrin pointed out many years ago, the use of small drops invalidates the method.

We give full details of the actual measurement made in our paper, and the means adopted to measure with high precision the distances between the photographic images of a drop, the optical magnification, the densities of the two oils used, the potential difference applied to the condenser plates and their separation. The values of e_0 and m with their errors are given in the table above.

The probable errors are calculated from internal consistency by means of a least square formula quoted by Birge in one of his valuable discussions of least square theory. It is evident that the oil drop methods used by us and by Millikan give values for e and m in close agreement.

In calculating e we have used in the table above $\eta_{23} = 1{\cdot}83006 \times 10^{-4}$. Since η_1 enters as $\eta_1^{3/2}$ in the expression for e, the value assumed for η as being the most probable is very important. We have critically examined nine recent measurements of η for air and derived a mean value. The error of the mean, $\pm\ 0{\cdot}0025 \times 10^{-4}$, is several times larger than the error of the more accurate of these values as estimated by internal consistency. There is this and other evidence that measurements of the viscosity of gases are subject to large systematic errors. The error in η mentioned contributes an error of 1 in 500 to e, and is now its main error by the drop method.

X-ray Method

In the X-ray method the lattice spacing, d cm., of a crystal is measured, and $e = 2d^3\phi(\beta)\rho F/M$, where $d^3\phi(\beta)\rho$ is the mass of the crystal molecule, M its molecular weight, and F the Faraday. This is done in several steps. First the wave-length, λ_g cm., of an X-ray line is measured. For example, the K doublet of aluminium was measured absolutely by Bäcklin using ruled gratings, and Söderman and Tyrén [2], using concave gratings, compared the aluminium line in

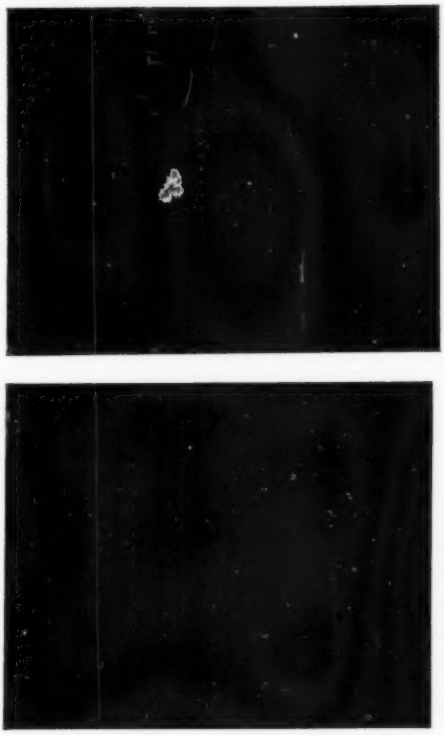

FIG. 2. PHOTOGRAPHS SHOWING PATHS OF DROPS BEFORE AND AFTER THE APPLICATION OF THE ELECTRIC FIELD.
Time interval between the appearance of consecutive images is 0·04 sec. Time of exposure for each image 0·0007 sec. Magnification of camera, × 12.

high orders with optical lines of the spark spectra of carbon, oxygen, etc., the wave-lengths of which Edlén had measured.

Next the wave-length of the X-ray line, λ_c X.U., is measured using an X-ray spectrometer and a crystal. Since for calcite λ_c Al $K\alpha_{12}$ is greater than $2d$, it cannot be used as the crystal. Mica, gypsum, and quartz crystals have been used. The lattice constant of the crystal used is compared with that of calcite using copper $K\alpha_1$ or other homogeneous radiation. The observations of Larsson, Siegbahn and Haglund agree closely, giving λ_c Al $K\alpha_{12} = 8322{\cdot}90$, where, as defined by Siegbahn (and always used by him), 1 X.U. $= d_{18}$ calcite/3029·45.

The expression $e = (\lambda_g/\lambda_c)^3\ 4{\cdot}77302 \times 10^{-10}$ is used to calculate e; it is calculated using the most probable values of ρ, $\phi(\beta)$, F and M.

X-RAY VALUES OF e

Bäcklin	$4{\cdot}8017 \times 10^{-10}$	Tyrén	4·8020
Söderman	$4{\cdot}8027 \times 10^{-10}$	Bearden (1935)	4·8029

Mean X-ray value $(4{\cdot}80.3 \pm 0{\cdot}001) \times 10^{-10}$ E.S.U.

If $\eta_{23} = 1{\cdot}8301 \times 10^{-4}$, the values of e are: Millikan, 4·799; Hopper and Laby, 4·8020; X-ray value, $4{\cdot}8023 \times 10^{-10}$ E.S.U., and the two methods agree.

[1] Hopper, V. D., and Laby, T. H., *Proc. Roy. Soc.*, A, **178**, 243 (1941).
[2] Tyrén, F., *Z. Phys.*, **109**, 722 (1938).
For reference to other workers mentioned in this paper see reference (1).

GEOLOGY IN CHINA

ANNIVERSARY OF THE GEOLOGICAL SOCIETY OF CHINA

TO say that the activities of Chinese geologists during the past few decades have been remarkable seems almost an understatement: our admiration of their achievements is quickened by the reflection that the Geological Society of China was founded only twenty years ago. Even under the handicap of present conditions, the Society recently celebrated its twentieth anniversary, when Dr. J. S. Lee, as chairman, delivered an inspiring address. We in Great Britain feel gratified when we remember that Dr. Lee is one of the many Chinese geologists trained in a British university (in this case, Birmingham), and we look forward to a resumption and even an extension of this practice after the War. By this means we make close scientific contacts (which benefit those who give no less than those who take) with a country vast in area, varied in physical features and diversified in rock-types.

In China we see a part of the earth's crust where geological processes have been developed on the grand scale. Although geological history cannot actually repeat itself anywhere, we can usually detect recurrent phases that show mimetic resemblances. Moreover, it would seem that although the principles of geological science are by their very nature applicable to all terrestrial areas, each major unit of the continental surface displays its own peculiar features. For example, the surprising geological discoveries made year by year in Africa remind us that, so early as Pliny's time, men were accustomed to look to Africa for things always new. Since then, North America, India and the U.S.S.R. have produced their crops of geological novelties; and now we can appropriately apply to China the well-worn aphorism. Even the popular imagination is stirred by such events as the unearthing of fossil dinosaur eggs or the skull of Peking man, but these discoveries are matched by no less remarkable, if more esoteric, discoveries in the fields of mineralogy, palæontology, stratigraphy and tectonics.

The two decades that have elapsed since the foundation of the Geological Society of China have seen great political upheavals in the country, the setbacks due to ideological rivalries and a bitter war of penetration arising out of the economic ambitions of a neighbouring power. Such conditions are certainly not favourable for the prosecution of scientific work, and we cannot but marvel at the way in which our Chinese colleagues have succeeded in carrying on both laboratory research and the primary survey of the rocks of their motherland in spite of manifold difficulties, of which transportation is not the least considerable.

Dr. Lee's review of progress in Chinese geology during the past twenty years is a timely reminder of what can be accomplished in adverse circumstances by devotion to science: it is also a stocktaking which serves to indicate those fields in which more knowledge is urgently needed. At the outset, he directed attention to the "extraordinary fact" (to quote his own words) ". . . how few is the number of papers dealing with the economic aspect of geology that appeared in the bulletin of this society. Among the reasons to account for this record, I would point out one: namely, that a non-utilitarian tendency has always constituted a strong trait in the character of Chinese intelligenzia throughout historical times".

The misuse of scientific discoveries and the perverted developments elsewhere lead him to the reflection that (as he puts it) handicaps such as those due to the absence in a country of any legacy of geological ideas sometimes turn out to be an advantage. The contrast in outlook is emphasized by the action of the covetous neighbour who has invaded China in order to exploit the natural resources, especially of minerals. Comparatively little is known about the potentialities of the huge area of China which, *sensu lato*, covers more than one tenth of the earth's land surface: their proper assessment will inevitably call for a large army of investigators, and the information thus acquired will materially affect any action taken to implement the Fourth Article of the Atlantic Charter.

Dr. Lee notes that the Geological Society of China, although a national organization, is in fact international in character, as witnessed by the roll of members, who come from all lands. Many have participated in the work of the Society and are welcomed in a fraternal atmosphere. As he pointedly says, "we have even adopted the leading Western languages, principally English, as the official means of communication, not without some sacrifice of our own convenience". For this, as also for the fact that he gave his address in English, we are very thankful.

Some of Dr. Lee's animadversions are in the nature of warnings to his geological colleagues not to rely too much on the range of fossils and on stratigraphical divisions established in other parts of the world. He cites as examples the discovery of the tabulate coral Tetrapora, formerly believed to be typically Permian, in beds so ancient as the Lower Carboniferous; of a species of Sphenophyllum hitherto unknown below the Stephanian coal measures of Europe, in the Wuntung Sandstone of Lower Carboniferous age; and of the Upper Devonian fish Bothriolepis in the lower part of the Middle Devonian. He mentions other instances in order to show that the stratigraphical value and zonal positions of fossils in China are not in conformity with records established elsewhere. There are considerable lacunæ, he says, in the fields of mineralogy and petrology, such as the study of the constituents of the sedimentary deposits and the natural history of the igneous and metamorphic rocks of China. Both merit further attention, and his country offers generous scope for these lines of inquiry.

The survey of complex petrological provinces has necessarily proceeded slowly and map-making has been delayed, a fact which reminds Dr. Lee to mention incidentally the appearance of a gorgeously coloured geological map of Southern China, published by a foreign institution (and we can make a shrewd guess at its source, knowing which nation specialized in such regional activities) at a time when even the larger units of the stratigraphy were scarcely known! But, as he says, the absence of authoritative geological maps of China invites such "indignities".

After dealing with the subject of mapping, Dr. Lee is led to a discussion of problems of palæogeography, and he takes the opportunity to warn his colleagues against the danger of inferring the onset of important earth-movements from evidence which denotes non-sequence rather than major unconformity. As a prelude to the discussion of geophysical phenomena and tectonics, he describes examples of rock deformations that may astonish Western workers, such as the yielding of tombstones under their own weight and of the bending of pebbles of chert and hard sandstone under a load of ice only 100 m. in thickness.

Dr. Lee's early attempts to classify the structural features and mountain forms of China are well known to us, for they found publicity in an English geological journal. In his view, these features fall into three dominant groups, the Cathaysian and Neo-Cathaysian trends (the former dating from the Palæozoic and generally running north-eastwards, and the latter probably late Mesozoic and running north-north-eastwards), the east-west fold-zones, and the various shear-forms. The dominant shear-forms, five or six in number, are of his epsilon-type and each extends over the whole or part of a segment of the continent and is separated from the other by fold zones, their arcuate convex fronts facing the equator. Dr. Lee sees this structure also in the sweep of the Eurasian arcs, combined with the backbone of the Urals, and suggests that a similar arrangement can be found in North America. From experimental results in the laboratory, he infers that these features are characteristic of the behaviour of a plasto-elastic material when subjected to stresses, and that in the earth's crust they result from "the horizontal component of the centrifugal force arising from the spin of the earth, or more probably from an increase of its rotational speed". Dr. Lee admits that his generalizations are likely to arouse scepticism in some quarters. He makes reference also to a rather better known effect of the earth's rotation when he records that, like the meridionally flowing rivers of Russia, the mighty Yangtze is at the present time undercutting steeply its right-hand bank after it leaves the gorges.

Dr. Lee concludes his address with a summary of the evidence for a polyphase Ice Age in China, in which there were not less than three separate glacial episodes. Incidentally, he correlates one with the "Würm of Europe": now, the Würm episode in the Alps is generally known, but opinions differ widely about the particular phenomena that distinguish its traces elsewhere.

Although only a few of its many interesting points can be mentioned here, we may take this opportunity to hail the address as contributory evidence of the virility of young China. P. G. H. BOSWELL.

ELECTRON LENSES*

By DR. D. GABOR

Research Laboratory of The British Thomson Houston Co. Ltd., Rugby

AS soon as H. Busch had established the analogy between axially symmetrical electromagnetic fields and optical lenses, a question very naturally suggested itself: "Can we make electron lenses as perfect as the highly corrected lenses of modern optics?"

Compared with light optics the new science started with a great advantage, and with a great disadvantage. Whereas in optical instruments the ratio of refractive indexes never exceeds 2 : 1, in electronic devices we can realize ratios of 1000 : 1 or more, by using sufficiently high accelerating voltages. Against this stood the great disadvantage that while modern applied optics has a great variety of glasses at its

* Substance of part of a lecture on "Electron Optics" before the Electronics Group of the Institute of Physics delivered on October 31. The complete lecture is being published in *Electronic Engineering*.

disposal, with a wide range of chromatic dispersivities, electron optics has only two media, the electric and the magnetic fields, both with fixed properties. Nor can we shape the electron lenses as freely as the optician figures his surfaces, as we are limited by the conditions of zero divergence for the electric field, and zero curl for the magnetic field (freedom from space charges and space currents).

It will be useful to sum up in advance the position as it is now, after fifteen years of theoretical and experimental research. It was *not* possible in theoretical electron optics to design perfect or at least highly corrected lenses of high power. The initial disadvantage proved too great. On the other hand, the electron optical art could solve all its immediate problems by availing itself of the great inherent advantages of electron optics, by the use of *high voltages*. Almost the only service theory could render was to point out the unavoidable limitations, thus saving the workers from wasting time and energy on *perpetuum mobili*.

The first question which arose was: "Can an electron lens form a point image of a point on its axis?" Two defects are possible, due to spherical and 'chromatic' aberration. O. Scherzer demonstrated in an important paper[1] that neither can be eliminated. These two fundamental weaknesses of electron optics are closely connected with the impossibility of realizing diverging electron lenses under the conditions required by present-day practice, namely, zero space charge, and zero electric field both in the object and in the image space. In principle, the spherical aberration could be corrected by suitably controlled auxiliary streams of ions or electrons. But so far, experimenters have not been tempted to follow this line, which is bristling with difficulties. It may be asked whether the space charge of the electrons themselves which forms the image could not be used for this purpose? In fact, a perfectly stigmatic beam carrying a finite current density is not in principle impossible*, as the electrostatic energy stored in it is finite. It may even be surmised that this method of compensation has been unwittingly but successfully utilized in many cathode ray tubes. But it is useless in electron microscopes. A hint regarding these came from R. Rebsch[2]. Though the spherical aberration can never be quite eliminated, it can be reduced below any limit, if the field of the objective is so shaped that it forms a very small, very weak 'prefix lens' extremely close to the object. But to realize this requires extreme mechanical precision, and there is no evidence that practice had availed itself of Rebsch's suggestion.

When it was discovered in 1936[3] that *electron mirrors* had chromatic errors of opposite sign to those of lenses, it seemed that there was hope of correcting for chromatic aberration. But this was a forlorn hope, for several reasons. In mirrors, the image field will cut out the paraxial rays, and correction to a very high order becomes necessary, or the mirror has to be placed in a skew position to the axis, and all the formidable difficulties of non-centred optical systems have to be faced, which even in light optics have only partially and recently been overcome. But apart from these theoretical difficulties, electron mirrors offend badly against what I should like to call the first principle of *practical* electron optics: "Do not slow down your electrons more than you can help".

I do not know whether this principle has ever been formulated, but the whole development of the electron optical art proves that it has been understood and observed. In fact, it is a very common experience in electron optics that electrostatic systems show performances far below theoretical expectations, and display defects far worse than could be accounted for by the geometrical inaccuracy of the electrode arrangement. The reason is that the electrode surfaces are often covered with what may be called somewhat vaguely *polarization layers*, which are often distributed in a patchy, irregular way, and can produce, between the surface and the body of the electrode, potential differences of several volts, sometimes even more than a hundred volts. So far as I know, they have never been systematically studied. Indeed, they present a rather typical case of a problem which is likely to be neglected. Academic circles cannot be expected to be interested in them, as they are far off the main road of progress. Industrial physicists have no time for this sort of problem; they will remove the difficulty by some *ad hoc* solution, or pass in a wide circle around it. But until the polarization layers are eliminated, all electrostatic systems using slow electrons are likely to be disappointing, and this is particularly true of electron mirrors.

Though, as we have seen, theory was not very helpful, electron optical practice has achieved brilliant successes. I have already mentioned the simple panacea of practice: *high voltage*. No high-power lenses were possible, but there was no need for them, because with sufficiently high voltages very much greater intensities† could be realized with electrons than with light. Moreover, the de Broglie wave-length of high-velocity electrons is very much shorter than the wave-length of visible light, so that, for example, at 60,000 volts the numerical aperture of an electron microscope could be cut down to 1/1000, and yet a hundred times higher resolving power could be realized than with a light microscope of unit numerical aperture.

With such narrow apertures even the aberrations of entirely uncorrected lenses become negligible, with the exception of the chromatic aberration. For this, however, practice had the simple remedy of monochromatic illumination, the electron optical translation of which is *constant voltage*. In the new commercial electron microscope of the RCA[4], the supply of 60,000 volts is kept constant within $\pm$ 1·2 volts, that is, 0·004 per cent, which means that the de Broglie wave-length of the electrons varies only by 0·002 per cent. In comparison, a sodium lamp is a very poor monochromatic source, as the two *D*-lines differ by 0·1 per cent, which is fifty times more. This almost perfect monochromatism is somewhat disturbed by the scattering in the specimen. But here again high voltage proves its claim as a panacea. The faster the electron, the less energy will it lose in a single collision, and if the specimen is sufficiently thin, the inhomogeneity of a 60-kv. beam emerging from it will be almost negligible, while the scattering (change of direction without appreciable difference in energy) is still sufficient to provide good photographic contrasts. Thicker specimens have been successfully investigated with 300-kv. electrons[5].

To sum up, practice has not waited for highly corrected lenses, but short-circuited the problem by pinhole apertures and monochromatic illumination. It appears even that further progress at the moment

* Strictly speaking, not *optically* impossible. For thermodynamic reasons a rigorously stigmatic beam can never be realized.

† Intensity is energy flux per unit area and per unit solid angle.

is not barred by lens imperfections, but by the polarization layers which form especially in the objective aperture[6]. This is one more reason for taking up their study in earnest.

Years ago, when highly corrected lenses appeared more important than at the present time, I often thought that it would be desirable to know the fields corresponding to *ideally stigmatic lenses*, regardless of the difficulty of their realization by current laboratory methods. After labouring on the problem without success for some time, I dismissed it from my mind, but recently when I again gave attention to the subject I found a very simple way leading to the solution. Though the result itself may not be of practical importance at the present stage of electron optics, I think that the method by which it is derived may be of interest.

Hamilton's Principle can be expressed in a form identical with Fermat's Principle

$$\int n.ds = \text{minimum},$$

where ds is an element of the trajectory and n is the electron optical refractive index. Let us apply this to the trajectories in the meridian plane of a lens. In this case n is independent of the direction, not only in electrostatic lenses, but also in the magnetic type, if we allow for the rotation of the trajectory around the axis.

Let us now map the meridian plane of the lens on a suitably chosen surface by a transformation

$$n.ds = dS,$$

where dS is the line element on the surface corresponding to ds. As n is isotropic, the transformation is *isomorphic*. A surface on which the meridian plane of the lens can be mapped in this way may be called a geodetic surface, as every electron trajectory will be mapped on it as a geodetic line[7].

This leads straight to the 'ideal lens', as it is obvious that *the geodetic surface of an ideal lens must be a sphere*. On a sphere the geodetics are great circles, and the great circles running through *any* point intersect again in its antipole, which can be considered as the rigorous image of the point considered. We can now map the sphere on a plane by *any* isomorphic projection known in cartography, and obtain an *ideal two-dimensional lens*. In order to obtain the ideal three-dimensional lens we choose the stereographic projection, on account of its central symmetry. This gives the following law for the distribution of the refractive index as a function of the radius vector r in the meridian plane :

$$n/n_0 = (1 + r^2/r_0^2)^{-1},$$

where n_0 is the refractive index at the centre, and r_0 a length which characterizes the dimensions of the lens. If we imagine this distribution rotated round any axis, we obtain the ideal three-dimensional lens. Because of its spherical symmetry, any trajectory will be contained in a meridian plane. The trajectories are one and all *ellipses*. An image of any point at a distance r_1 from the centre will be formed rigorously at a point on the same diameter at a distance r_2, and the simple relation between the two is

$$r_1.r_2 = r_0^2.$$

Image formation is therefore the geometrical transformation known as *inversion*. It can be proved that the three-dimensional ideal lens is unique. If there were other ideal lenses, they could be derived from the one described by isomorphic transformations. But according to a theorem of Liouville the group of isomorphic transformations in three dimensions is identical with the group of inversions, and according to a theorem of Cayley and Klein the group of inversions represents, by stereographic transformations, the rotations of a sphere on itself. As rotations of the geodetic sphere on itself are irrelevant, the ideal lens is transformed into itself, and is therefore unique.

Though it may be satisfactory to know that the ideal lens exists in the mathematical sense of 'existence', no immediate practical application can be expected, as it cannot be realized without space charges. The same is true of the infinite number of two-dimensional (cylindrical) ideal lenses, though some of these may be capable of approximate realization. These are all derivable from the 'stereographic' distribution by any conformal representation in which the action is kept invariant :

$$n.ds = n'.ds'.$$

It may be hoped that such representations will have other, less ambitious but more immediately fruitful applications, as they allow the transformation of one electron optical problem into another, and may even hold the key to certain space-charge problems, for which no satisfactory mathematical treatment has yet been found.

[1] Scherzer, O., *Z. Phys.*, **101**, 593 (1936).
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HEALTH EDUCATION IN GREAT BRITAIN

MANY of the most important institutions in Great Britain have, like Topsy, 'just growed', and among them is the Central Council for Health Education. Set up originally in 1927 as an offshoot of the Society of Medical Officers of Health, it has grown until it is now recognized by the Government as "the one agency for general health education in England and Wales", with thirty-nine members of staff and fifty-four active recognized lecturers. Since the Council, at the instigation of the Ministry of Health, took over in April of this year the major part of the work previously carried out by the British Social Hygiene Council, together with most of the staff responsible for it, its activities have increased enormously. The Council has regional offices in various parts of the country, which facilitates work considerably, and encourages local initiative.

The general public is probably most familiar with the Council's poster advertisement—indeed "Coughs and Sneezes spread Diseases" has become a national slogan. Posters are available for the use of local authorities in sufficient diversity to cover most conceivable needs. The disease-spreading proclivities of the rat and the fly ; the life-histories of the bug, the louse and the scabies mite ; the importance of diphtheria immunization and whooping-cough inoculation ; the desirability of rambling, cycling and camping ; the benefits to be derived from breast-feeding and attendance at infant welfare clinics—

all these and many other health lessons may now be brought to the attention of the public by display on the hoardings. Local authorities are not slow to appreciate the advantage of this centralized poster production, as evidenced by the fact that in the first six months of this financial year, the Central Council has disposed of some twenty-three thousand posters and bills.

Apart from posters, the main medium of printed propaganda is the leaflet. Most of the Central Council's leaflets fall into several attractive series such as "Health Hints", "Hints from the Health Department" and "Shelter Bulletins". These cover a wide field of health education, ranging from brief outlines of diseases such as diphtheria, measles, whooping cough, infantile paralysis, tuberculosis and influenza, to the importance of bodily and sartorial cleanliness, sleep and the adequate feeding of baby, toddler and expectant mother. In addition, several pamphlets are available; while those leaflets and pamphlets dealing with the biological approach to sex education and the problems of venereal diseases (taken over from the British Social Hygiene Council) are, after suitable revision, being re-published in similar format. The scope of this type of publicity may be estimated by the fact that in six months some 885,000 leaflets and pamphlets have been distributed by the Central Council. Not content with this range, the Council is actively engaged on the preparation of new pamphlets dealing with the health of school-children (from the points of view both of the teacher and of the parent), with the problems of adolescence (for youth leaders), with the health of factory workers, and with biology as a medium of health education in the school; and of new leaflets concerning the health of the worker, the care of the feet, advice to dyspeptics, and other topics. In addition, an illustrated health booklet for children will soon be available.

A central health education agency could scarcely regard its work as satisfactory in the absence of a periodical, and the Central Council is in the fortunate position of having two. *Better Health*, a small popular monthly, achieves a circulation of 50–60,000, and, when paper limitations are removed after the War, should reach many times this figure. In addition to a popular magazine for the general public there has, however, been for many years a real need for a journal of a more specialist nature, to cater for those many people actively working in the field of health education. This need should be met by the publication, in January of 1943, of the first number of a new quarterly, *Health Education*. Articles by specialists will help to give educationists more information on medical matters, and medical people more on matters of education.

The first number will contain a message from the Minister of Health. Dr. Allen Daley (chief medical officer of the London County Council) will contribute an article describing the beginnings of health education in Great Britain, while Prof. J. M. Mackintosh will give his views of the primary aims in health education, and Dr. Charles Hill (chairman of the Central Council) will consider radio as a medium of health education. Mr. W. B. Little will discuss health education from the point of view of the school-teacher, and Dr. J. L. Picton from that of the general practitioner, while the problems of sex education will be considered by Mr. Cyril Bibby (education officer of the Central Council). This new journal should prove of the greatest value to medical practitioners, teachers, youth leaders, social workers, medical and educational administrators and indeed to all seriously interested in the matter of health education.

No educational body to-day can afford to neglect the medium of the film, and the Central Council has not been backward in this respect. It now has available for the use of local authorities some fifty films, covering the most varied aspects of health education. Droplet infection, nutrition, the care of the skin and of the feet, the conquering of fear, the historical development of the public health services, the biological approach to the study of sex and reproduction, the venereal diseases—all these are dealt with in the Council's films, in manners suitable for the most diverse audiences, from school-children and the general public to educationists and medical practitioners. Not content with this range of subjects the Council has at present in production new films on the head louse, venereal diseases, infant welfare clinics, and a film fantasy for children, showing the importance of cleanliness, exercise, fresh air, and good food.

During the last six months the Council's films have been shown at some four hundred special meetings. In addition, more than three hundred health films have been dispatched to a hundred borrowers. To meet this demand for visual health education the Central Council employs seven film operators, and possesses ten film and six film-strip projectors.

The radio is also a medium of the utmost importance, and it has not been neglected. In collaboration with the Central Council for School Broadcasting, the chairman of the Central Council for Health Education has given many health talks to school-children; and millions must hear him as the "Radio Doctor" in the B.B.C. programmes.

Important as all these methods of health education undoubtedly are, perhaps most potent of all is the spoken word of a lecturer to his audience. With the helpful co-operation of local authorities and the various national voluntary organizations, the Central Council arranges large numbers of meetings for many different types of audience, and more often than not the meetings are illustrated by films. During the six months from April 1 of this year more than 75,000 people have been reached in this way.

This number is but a small part of the total population of Great Britain, but many audiences are highly selected, consisting of influential persons, who will pass on the knowledge obtained to, or will be influenced in their dealings with, many others. This is particularly true of the meetings for school-teachers, who have such a great influence over children and young people. Thus it is reasonable to expect that the 762 teachers who have during these six months attended lectures at eleven different centres in the country will, as the years go by, affect favourably tens of thousands of the future citizens of the country. These teachers' refresher courses have dealt with the biological approach to problems of sex and of health generally, and have been fairly thorough courses of up to twelve sessions. The Central Council has built up a comprehensive display library of biology and hygiene books, and teachers have been very grateful for the opportunity of examining it at the meetings.

Similar significance beyond the mere figures of attendance applies to the 1,566 youth leaders and welfare supervisors who have in the same period attended courses dealing with the problems of adolescence; and to the 1,111 parents who have taken part in meetings dealing with the sex and health education of children.

An important feature of the work of the Central Council is the talks on sex and general health problems given directly to school-children and young people. No fewer than 1,466 of the former and 4,596 of the latter have attended courses of lectures given in this half-year in sixty different parts of the country, and all the signs are that the figures for the next half-year will be even greater.

During the period under consideration, approximately three thousand civil defence workers and seven thousand troops have attended meetings organized by the Central Council for Health Education, while factory meetings have reached some thirty-nine thousand workers.

Work of this variety and of this extent is possible only by the collaboration of skilled personnel and influential national organizations. Under its president the Archbishop of Canterbury, the Central Council meets as a widely representative body. Of Government departments, the Ministry of Health, the Board of Education, the Ministries of Food, Labour and Information, the Welsh Board of Health and the Scottish Education Department all have either representatives or observers on the Council or its Committees. In addition, there are representatives from the County Councils Association, the London County Council, the Association of Municipal Corporations, the Non-County Boroughs Association, the Metropolitan Boroughs Standing Joint Committee, and the Urban and Rural District Councils Associations.

The collaboration of the professions most concerned with health education is assured by representation from the Society of Medical Officers of Health, the British Medical Association, the Royal College of Nursing, the Dental Board of the United Kingdom, the British Dental Association, the Association of Directors and Secretaries for Education, the Association of Education Committees, and the National Union of Teachers. The field of health insurance is covered by representatives of the National Association of Insurance Committees, the Association of Welsh Insurance Committees and the London Insurance Committee, while collaboration with other health organizations is achieved by representation from the Conference of Affiliated Societies. In addition, the Council's Educational Advisory Committee has the benefit of the knowledge and experience of representatives from the British Medical Association, the Association of Women Science Teachers and the Science Masters' Association, and of many distinguished educationists (see also NATURE of November 7, p. 529).

Thus for the first time Great Britain has a really large and representative organization with skilled personnel devoted entirely to the enormously important work of health education; and the country should benefit greatly from it.

NEWTON TERCENTENARY

ROYAL SOCIETY CELEBRATIONS

THE anniversary meeting of the Royal Society, which is held on Saint Andrew's Day, November 30, was this year devoted, for the most part, to commemorating the tercentenary of the birth of Isaac Newton. The proceedings, which took place in the lecture theatre of the Royal Institution, were opened by Sir Henry Dale, president of the Royal Society, and the main part of his address is printed below.

We are within a few weeks of the three hundredth anniversary of the birth of Isaac Newton. Wherever the progress of our Western science and philosophy has become effective, men will remember what that event was to mean for the world. Newton, at the age of forty-three, when he had determined to abandon all further concern with natural philosophy, was induced at length, by Halley's friendly insistence, to give written form and system to the mathematical discoveries with which his amazing mind had been occupied over a period of some twenty years. The result was one of the greatest intellectual achievements in the history of mankind—the "Principia", providing for more than two centuries a framework for the mechanical interpretation of the universe and a basis for the building of physical science, and therewith of the material structure of our modern civilization.

We in Britain regard Isaac Newton as still, beyond challenge, the greatest of our men of science. Nor should the claim be limited to this island or to the British Commonwealth of Nations; for it was not until nearly half a century after Newton's death that former British colonists in North America began their development of an independent nation; and Newton is theirs as well as ours.

But, while we may proudly claim him as the countryman of all who share the birthright of the English tongue, the discoveries of science have belonged, and must belong again, to the whole world, and Newton's achievement is a part of the common heritage of all peoples. It cannot be doubted that, if it had fallen in normal times, this tercentenary would have been marked by the greatest of international gatherings, in which men of science and philosophers from all the world would have assembled to do honour to Newton's memory. It would have been natural then to expect leadership, in such an enterprise, from the only two institutions which were intimately concerned with Newton's career as a man of science—Trinity College, in Cambridge, and this our Royal Society of London. Our two foundations did, indeed, confer as to the wisdom of attempting by joint action, even in this year of war, to arrange such a restricted and domestic celebration as the present conditions would allow. We agreed, however, to put aside such planning for the present, carrying it forward in our hopes to the time when a world at peace may be able to join in international commemoration of an event which has meant so much for all mankind. May the time be not too far distant.

In the hamlet of Woolsthorpe, near Colsterworth on the Great North Road, some six miles south of Grantham, there is still a modest manor farm-house, with a small orchard in front of it. Here the Newtons lived, simple yeoman farmers, and here, two months after his father had died, Isaac Newton was born, a puny, premature infant, on Christmas day 1642, twenty years before the Royal Society was incorporated by the grant of its first Charter. The house stands but little altered since that day. The room in which Newton was born has a simple marble

tablet on the wall, inscribed with Pope's well-known couplet. But this house had importance in Newton's later life and in his work, and not only as his birthplace. It was here that he returned from his schooling at Grantham, at the age of sixteen, to take charge of the farm for his mother; and here, to the incalculable gain of science and the world, he showed such incompetence as a farmer that he was sent back to school, and thence to Cambridge. It was here, again, that he returned in the autumn of 1665, when the plague drove him from Cambridge; and here, during the following eighteen months of quiet exile in the country, his early ripening genius grasped already the essential principles of his major theoretical discoveries. You can still see the upper chamber which he then used as a study; and in the little orchard there is an old, recumbent apple tree, which, they will tell you, is descended by direct grafting from that which Newton saw. The land which Newton's family farmed is rapidly being laid waste, alas, by quarrying for ironstone; and soon there will be little left unspoiled save the orchard and garden around the house.

It has seemed to us that, in this year of commemoration, something should be done to preserve for posterity a house and garden which carry such momentous memories, and which have meant so much for science. We have accordingly formed a small committee, in which Sir John Russell and Sir James Jeans have joined with the officers of the Royal Society; and we are in negotiation with the lord of the manor as to the possibility of acquiring this now tiny but historic property, so that it may be put for as long as possible beyond the risk of damage or decay.

Then I think that it is our special duty at this anniversary meeting to remember that, while Newton's great discoveries belong to the world, they came to publication through the Royal Society, and that Newton occupied its presidential chair for the last twenty-four years of his long life. Though his "Opticks" was not published until after he had become president, his original work for science was practically finished by the time of his election, and he had for some years been Master of the Mint. There can be no doubt, however, that the wide fame of his achievements, and the respect and admiration in which he was everywhere held, did much, at a critical period in its history, to establish the prestige of this Society in the eyes of the world. Let us then remember to-day that Isaac Newton, the greatest man of science of our race, was also the greatest of the Royal Society's presidents.

Sir Henry Dale also referred in appreciative terms to the attitude of the present owner of the Newton house and garden at Woolsthorpe, Major Christopher Turnor, who had expressed his willingness to dispose of the property for less than its value, for preservation as a Newton memorial. Sir Henry added that he had just learned that the Pilgrim Trustees would defray the cost of purchase. A photograph of the house was reproduced in NATURE of March 26, 1927 (Supp. p. 34), on the occasion of the two hundredth anniversary of Newton's death.

Sir Henry Dale's address was followed by lectures by Prof. E. N. da C. Andrade on "Newton and the Science of his Age", Lord Rayleigh on "Newton as an Experimenter" and Sir James Jeans on "Newton and the Science of Today". The manuscript of the first edition of the "Principia", the reflecting telescope and a solar sundial made by Newton, and other Newtoniana were exhibited in the library of the Royal Institution, together with demonstrations arranged by Lord Rayleigh to supplement those which accompanied his lecture.

OBITUARIES

Prof. J. N. Collie, F.R.S.

By the death on November 1 of John Norman Collie, chemistry has lost one of her most outstanding personalities. To me, who knew him well from January 1889 until September 1939 when he left London to live in Skye, Collie was a true guide, philosopher and friend, and to-day it is my privilege to write of him as one of his last remaining friends for fifty-three years.

Collie was born on September 10, 1859, and was the son of the late John Collie. He studied chemistry under Prof. Letts at Bristol and afterwards was associated with Letts in two original investigations, the first on dimethylthetine ethyl ester and the second on tribenzylphosphine and tetrabenzylphosphonium salts.

In September 1888 Collie was appointed by Prof. W. Ramsay demonstrator in the Chemical Laboratories in University College, London, and I first met him when I entered the College as a young student in January 1889. Those of us who learned qualitative analysis under Collie found in him a born teacher, gifted with a salutary sarcasm which was tempered with a real understanding of the difficulties presented by a hitherto unknown field of study and provoked by strange results unrecorded in any text-book.

In 1896 Collie left University College on his appointment to the chair of chemistry in the College of the Pharmaceutical Society in Bloomsbury Square, London. In 1902 Collie returned to University College as professor of organic chemistry under Sir William Ramsay, the director of the Chemical Laboratories.

In the years following this appointment, Collie built up a great school of organic chemistry, and many men of high distinction to-day received their inspiration from him. Amongst these may be mentioned Prof. S. Smiles, Prof. T. P. Hilditch, Prof. A. W. Stewart and Dr. Irvine Masson. Just as on a ship the master is called the "Old Man", so it was in the organic laboratory, for Collie was invariably referred to as the "Old Man", a title of which he was very proud, for he knew all that in it lay—unbounded respect, admiration and affection.

Since my contacts with Collie in those years were mainly outside organic chemistry, it is more fitting that another should pay tribute to him as one of the great organic chemists of his time. Prof. Smiles writes: "I hesitate to compare Collie and Perkin, they were so different and yet supreme in their own line in their day. If I must compare them, I would attempt an analogy, a poor one as all such must be. Collie I would regard as the landscape gardener, whilst Perkin was the energetic producer of really fine crops of new varieties. Collie took a very broad view of the subject, the relations of various parts of it to one another, and of the whole to other branches

of chemistry. He was no specialist, anything which savoured of narrowness was repugnant to his nature, but he was a true philosopher. It was this that made his lectures and his teaching so interesting, for there always seemed to be something intriguing beyond the horizon of what he was saying. Collie always seemed to publish reluctantly, but anything he did publish was nearly always of a fundamental character; for example, dimethylpyrone and the related compounds which led to his really comprehensive generalization on the polyketides. Collie was the first to suggest a labile formula for benzene, which was familiarly known in the laboratory as the 'Collywobble'. Moreover, his investigation of naturally occurring compounds, necessarily in small quantities, led him to devise his semi-micro method of organic analysis long before the days of Pregl."

In 1913, when Ramsay retired, Collie was appointed director of the Chemical Laboratories at University College, a position he held until his retirement as emeritus professor in 1928.

Now Collie was endowed with a remarkable versatility. In my days as a young student, he gave me what he called the education of a gentleman. At a series of dinners in his rooms in Camden Grove, he discoursed at length on the beauty of early printing and incunabula, the glories of Chinese lacquer, the grace of Japanese carving and the knowledge and appreciation of vintage clarets, each subject being illustrated by valuable examples.

Collie was also a true æsthete, for beauty wherever he found it made a strong appeal to him. During his investigations with Dr. Patterson on the effect of high potential electric discharges on gases at low temperatures, his great friend the late Sir Herbert Jackson said to him, "Collie, I truly believe that you are far more interested in the colours of the discharge than in the striking phenomena you are recording."

As is well known, Collie was an expert rock climber, but he was also a great mountaineer. He climbed many of the Alps, and in 1901, together with Mummery and Hastings, he attempted the ascent of Nanga Parbat in the Himalaya. In 1902, together with Stutfield, he climbed and explored among the Canadian Rockies, where he discovered the Columbia Group. The first expedition was described in "Climbing in the Himalaya", published in 1902, and the second in "Climbs and Exploration in the Canadian Rockies", published in 1903 under the joint names of Collie and Stutfield. Collie was in turn president of the Scottish Mountaineering Club, the Alpine Club and the Royal Geographical Society.

In 1903 Collie invited me to join a party who proposed to climb in the Lofoten Islands. This party included those other great men of the mountains, James Collier, William Cecil Slingsby and Herman Woolley. Under their tuition I learned the elements of the art, and in the following year Collie invited me to join him at Sligachan in the Isle of Skye. There it was my privilege to meet and later to climb with John McKenzie, the guide and ghillie of the hotel. John was a man of fine personality and under Collie's tuition he became a first-rate rock climber. It is true to say that John worshipped the ground on which Collie trod. Whether it were in walking, fishing or climbing, they were inseparable companions, and to those who knew them both it is singularly fitting that Collie was laid to rest alongside John's grave on the shores of Loch Harport, surrounded by the Mountains of the Mist they loved so well.

E. C. C. BALY.

Capt. G. T. McCaw, C.M.G., O.B.E.

CAPT. GEORGE TYRRELL MCCAW, who died on October 17, was the editor of the *Empire Survey Review* and one of the foremost and best known authorities on geodesy in the British Empire.

McCaw was born in Lurgan, Co. Armagh, Northern Ireland, in 1870, and, after a distinguished career at Trinity College, Dublin, graduated in arts and engineering in 1893. From 1893 until 1903 he was employed in the Irish Land Valuation Department, but, in 1903, he accepted an offer to join the Geodetic Survey of Rhodesia under the direction of the late Sir David Gill, at that time H.M. Astronomer at the Cape. This work lasted until 1906, after which he was engaged on the survey of the 30th meridian in Uganda, on the measurement of a base line in Sweden, and then in charge of the Trigonometrical Survey of Fiji, his published report on this survey being a model of what such reports should be.

McCaw returned from Fiji in 1917 and very soon afterwards joined the survey and mapping organization of the British Army G.H.Q. in France, where he acted as geodetic adviser connected with the co-ordination of the triangulation over the whole front. After the War he became technical assistant at the Geographical Section of the General Staff, War Office, and remained there until he retired in 1936. During this period he also acted as joint secretary of the Colonial Survey and Geophysical Committee and of the Air Survey Committee, his work in the former capacity bringing him into touch with surveyors and geodesists from all over the Empire. On several occasions he attended, as one of the British delegates, meetings of the International Union of Geodesy and Geophysics, and he often spoke at meetings of the Royal Geographical Society when technical matters relating to geodesy or survey were under discussion. He was a voluminous writer on geodetic subjects, and in 1931 he became the first editor of the *Empire Survey Review*, a semi-official journal which was founded under the patronage of the Secretary of State for the Colonies, mainly for the dissemination of technical information among the different Colonial survey departments. The high standard with which he launched this *Review* was maintained, in spite of difficulties caused by the War, until the time of his death. He himself, particularly during the War years, wrote a considerable part of each issue, and most of his contributions contained much matter that was original.

In 1924 McCaw was created O.B.E. (Civil Division) and in 1936, in view of his long connexion, both directly and through the Colonial Survey Committee, with survey matters in the Colonies, and the part that he had played in their development, he was made C.M.G.

Considerable as were his intellectual attainments, McCaw will chiefly be remembered by a very large circle of friends all over the world for his great personal charm, which endeared him to all with whom he came in contact. His advice, constantly sought by young and old, by junior and senior, was at the disposal of anyone who cared to ask for it, and, for that reason, most members of the various Colonial survey departments, when at home on leave, were glad to take the opportunity of calling at his office to discuss with him their own difficulties and problems. He was a most entertaining companion and a loyal and generous friend who was utterly incapable of a mean action.

J. CLENDINNING.

NEWS AND VIEWS

Joint Council of Professional Scientists

A JOINT COUNCIL of Professional Scientists, representing more than ten thousand qualified men of science, has been set up under the chairmanship of Sir Robert Pickard by the Institutes of Chemistry and Physics in association with representatives of professional botanists, geologists, mathematicians and zoologists. The Council has been established to voice the collective opinion of qualified scientists on matters of public interest, to provide a liaison between professional organizations of scientific men for co-ordinated action in matters of common interest, and in particular to concern itself with: (1) the utilization of men of science to the best advantage in the service of the community; (2) the education, training, supply and employment of scientific workers; (3) the better understanding of the place of men of science in the community; (4) the maintenance of adequate qualifications and ethical standards among professional men of science; (5) the supply of information and advice to public and other bodies on matters affecting men of science.

The members of the Council are as follows: *Institute of Chemistry*: Dr. J. J. Fox, Prof. Alexander Findlay, Dr. G. Roche Lynch, Sir Robert Pickard, Dr. H. A. Tempany, Mr. R. B. Pilcher; *Institute of Physics*: Sir Lawrence Bragg, Prof. J. A. Crowther, Mr. E. R. Davies, Dr. B. A. Keen, Dr. H. Lowery, Dr. H. R. Lang; *Representing Botanists*: Prof. W. Brown; *Representing Zoologists*: Prof. D. Keilin; *Representing Mathematicians*: Prof. S. Chapman; *Representing Geologists*: Prof. H. H. Read. The Joint Council has been established for the period of the national emergency, but it may form the nucleus of some more permanent organization to facilitate the close collaboration between professional men and women practising in all branches of science. Communications to the Council should be addressed to Dr. H. R. Lang, Honorary Secretary, Joint Council of Professional Scientists, c/o The Institute of Physics, at its temporary address, The University, Reading, Berks.

Industrial Reconstruction in Great Britain

A STATEMENT on "A National Policy for Industry" has been issued by a group of 120 industrialists in Great Britain as a contribution to the discussions on reconstruction (*The Times*, November 11). The statement, while urging that, as a producer, industry is by far the largest contributor to the material welfare of the nation, recognizes that industry has a three-fold public responsibility: to the public which consumes its products; to the public which it employs; and to the public which provides the capital by which it operates and develops. The underlying conviction of the whole document is that the spirit which should animate industry is service to the community as a whole, and emphasis is laid on four principles: (1) that the primary duty of industry is to the consumer; (2) that industry should acknowledge by accepting a code of performance towards the workers the partnership of labour in industry; (3) that in any central or sectional organization of industry special steps should be taken to safeguard the interests of small producers; and (4) that whatever form the further organization of industry may take should be and should remain a matter for the determination of Parliament.

The first part of the statement makes a spirited defence of the private enterprise in Great Britain under which industry has shown the essential qualities of imagination, boldness and resource, and the signatories consider that it is a necessary condition of achieving the requisite efficiency that the system of private enterprise continue. It is held nevertheless that the general standard of management can be further improved and that every possible step must be taken to achieve that end. Moreover, industry must recognize its social obligations in contributing to the work of physical reconstruction which will be necessary after the War. In regard to the suggested code of obligations towards employees, the statement refers specifically to co-operation with the trade unions, the development of works councils, holidays with pay, reasonable hours of work, a scheme of family allowances for children, and to part-time compulsory education up to the age of eighteen.

To assure to the consumer the full benefit of technical progress reflected in higher quality or lower prices or both, while establishing greater security for all, the signatories suggest that relations between firms, between different industries and between industry as a whole and Government, should be more fully and comprehensively organized in some form of permanent association. They advocate the classification of industry into sections, each of which should establish a sectional association charged with the duties of co-ordinating the activities and securing the collaboration of all producers in its own section. Beyond this they contemplate a Central Council of Industry representative of the whole of industry in Great Britain. In regard to the specific powers to make regulations and enforce decisions and membership which should be given to the association and Council, the statement points out that this is a matter for the determination of Parliament. It is recognized that ample provision should be made for the protection of the public as consumer, as well as of the small producer, and the establishment of an industrial tribunal or commission is suggested to which appeal could be made.

Colonial Policy

IN the House of Commons on November 26, Sir Edward Grigg moved an amendment to the address in reply to the King's Speech, in which he welcomed the declaration that it is desired to raise the standards of life of peoples in the Colonies, but regretted the lack of mention of specific proposals, including the establishment of a Colonial Development Board. He urged that further arguments about charters and abstract principles are no use, and that machinery should be set up at once to investigate the problems presented by the various Colonies, in order to be able to arrive at an agreed policy on them in relation with other Powers. In the course of the debate, reference was made to the unfortunate effect which may be produced in the Colonies themselves by the frequent changes during recent years in the Colonial Secretaryship.

Mr. Harold Macmillan, Under-Secretary for the Colonies, who replied for the Government, explained that Mr. Oliver Stanley, who has just succeeded Lord Cranborne as Secretary of State, could not be expected to define his attitude immediately. Meanwhile Mr. Macmillan outlined the present position in general terms. As regards the West Indies, he said that £1,500,000 has been spent on schemes under the Welfare Act, and a similar sum provided

for the banana industry. Rice production is being developed. In British Guiana a series of drainage schemes are starting which it is hoped will revolutionize rice growing. The most important thing, however, is to attack illiteracy. The growing political consciousness of the Colonial peoples must be developed on sound lines, but the diversity of conditions in the Colonies makes a standardized approach inapplicable. Continuous association of Colonial peoples with their own welfare and development, and co-operation of all concerned, from the highest to the humblest official, in this endeavour, are the methods to be used. Sir Edward Grigg's amendment was then withdrawn.

International Copyright

MR. G. WREN HOWARD and Mr. Stanley Unwin, both of whom are past presidents of the Publishers Association of Great Britain, have issued a statement raising the thorny issue of international copyright. They point out that the last International Copyright Convention, signed at Berne in 1908, afforded a very considerable degree of protection to the literary and artistic property belonging to the nationals of those countries which signed it. The position to-day, however, is that, of the major active members of the United Nations, the British Empire alone is adherent to the Berne Convention. While Germany, Italy and Japan signed it, the United States of America, the U.S.S.R., and the Chinese Republic did not do so. For practical purposes, almost complete protection is enjoyed by the literary property of United States citizens throughout the British Empire, but it is difficult, owing to the conditions imposed, for British subjects to obtain copyright for their property in the United States. Again, while a translation from the Russian into English is copyright in Great Britain and throughout the Empire, no copyright is afforded to any British literary material by the U.S.S.R.; in China, a considerable trade in material reproduced by photographic process has grown up. It is therefore urged that steps should be taken forthwith, as a part of the plans for reconstruction which are under discussion, to introduce a system of international copyright as soon as world conditions permit.

Exhibition of Newton's Books

AN exhibition of books connected with Newton is being held in the Wigan Central Library from November 23 until early in 1943, to celebrate the tercentenary of the birth of Sir Isaac Newton, at Woolsthorpe, Lincolnshire, on Christmas Day 1642. The exhibition was conceived and organized by the borough librarian, Mr. Arthur J. Hawkes. He has managed to bring together from the resources of the Wigan Library, supplemented by a few books on loan, a most interesting collection of early works on science. It includes copies of most of Newton's published scientific papers and books, together with about one hundred works of earlier and contemporary authors bearing on Newton's discoveries. The original issues of the *Philosophical Transactions of the Royal Society* in the possession of the Wigan Library are exhibited, together with the first editions of Newton's "Opticks" (1704), loaned by Messrs. Bernard Quaritch, Ltd., and the "De Revolutionibus Orbium Coelestium" by Copernicus (1543), loaned by the Earl of Crawford. Messrs. Sotheran, Ltd., have loaned the copy of Isaac Barrow's edition of Euclid which was used by Newton as a student at Trinity College and bears many annotations in Newton's handwriting. All the books exhibited carry lengthy notes attached to them explaining their interest and significance in connexion with Newton.

The exhibition was opened on November 23 by Mr. Leonard Stanley Newton, who is a descendant of the Woolsthorpe family. Wigan is to be congratulated on not letting pass, in war-time, the occasion to celebrate the three hundredth birthday of Newton by the exhibition of "so many and valuable philosophical truths as were never yet discovered and put beyond dispute by the capacity and industry of any one man whatever".

Ministry of Health: Medical Advisory Committee

THE Parliamentary Secretary to the Ministry of Health stated in the House of Commons on November 28 that a Medical Advisory Committee has been set up to advise the Minister on the medical aspects of problems relating to the health of the people. The members of the Committee are:

The presidents of the Royal College of Physicians, the Royal College of Surgeons, and the Royal College of Obstetricians and Gynaecologists; the chairman of Council of the British Medical Association; Dr. G. C. Anderson; Dr. J. C. Arthur; Miss A. Bloomfield; Dr. J. A. Brown; Dr. E. Rock Carling; Dr. J. A. Charles; Prof. H. Cohen; Dr. W. Allen Daley; Lord Dawson of Penn; Dr. E. A. Gregg; Lord Horder; Sir Wilson Jameson (vice-chairman); Dr. W. S. Macdonald; Dr. A. A. Moncrieff; Prof. R. M. F. Picken; Prof. H. Platt; Dr. A. T. Rogers; Dr. D. O. Twining; Dr. O. Williams; and Miss A. L. Winner.

Imperial Institute of Entomology

SIR GUY MARSHALL retired recently from the post of Director of the Institute and has been succeeded by Dr. S. A. Neave. The work of the Institute is well known. It publishes the *Review of Applied Entomology* and the *Bulletin of Entomological Research*, identifies insects submitted by entomologists from all parts of the world, distributes collections of named insects, provides initial stocks of parasites of economic importance, and acts generally in an advisory capacity and as a clearing house for matters connected with applied entomology throughout the Empire. A vacancy on the staff has just been filled, but there will be two others within the reasonably near future, and suitable candidates for these posts are now being sought. Further information can be obtained from the Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1, and applications made by May 1.

Bicentenary of Nicolas Leblanc

AMONG the world's benefactors whose discoveries have been ill-requited by their fellows was the French surgeon and chemist, Nicolas Leblanc, who was born at Ivry-de-Pré in the Département of Cher on December 6, 1742. Though of poor middle-class parents, he was able to study medicine at the Collège de France and ultimately became surgeon to the unfortunate Louis-Philippe-Joseph, Duke of Orleans. In 1775 the Paris Academy of Sciences offered a prize of 2,400 livres for a practical process of producing soda from common salt. By 1787 Leblanc had solved the problem, and through the generosity of the Duke was enabled, with Dizé, to erect a factory at St. Denis, and in 1791 a patent was granted him. In

1793, however, the Duke fell beneath the guillotine, and the factory was confiscated. Though in later years the factory was restored to Leblanc, together with a small monetary recompense, it was all in vain. Leblanc struggled hard against his misfortunes, but at the age of sixty-three his mind gave way and on January 16, 1806, he committed suicide. His process, however, gradually came into use and in 1883 Dumas, speaking to the Paris Academy of Sciences, said that the annual consumption of carbonate of soda in Europe and America, produced by Leblanc's process, was then estimated at between 700,000,000 and 800,000,000 kgm. In spite of this, little was known of the discoverer. Four years after Dumas spoke, a bronze statue of Leblanc was erected in the forecourt of the Conservatoire des Arts et Métiers in Paris.

Simplified Electrically Heated Hotbeds

A REPORT, Ref. W/T7, by C. A. Cameron Brown and E. W. Golding, issued by the British Electrical and Allied Industries Research Association, describes experiments carried out to determine whether a simple method of heating hotbeds electrically can be applied successfully to the intensive production of early salad crops in small frames such as are used by non-professional growers. The method consists essentially in equipping a frame with a soil-heating cable or with a transformer-fed bare iron wire to give a loading of 2–5 watts per sq. ft. Heating is controlled, from a convenient point in the domestic premises from which supply is taken, to give certain regular 'doses' of heat in each 24-hour period. These doses vary from 40 to 45 watt-hours per sq. ft. per day, depending on the district. The two most convenient modes of procedure appear to be either with a loading suitable for all-night running or with a lower loading suitable for continuous running. The method is designed for operation on the domestic two-part tariff and to take advantage of the low running charges available. The experiments have shown that the method is a practical and economical way of producing lettuces of first-class quality from mid-March onwards, with little attention and at a total cost, including overhead charges, well below the current retail prices in shops. While early lettuce is the main crop, other crops can be raised, either simultaneously, such as carrots, or in succession, thus adding to the value obtainable from the hotbed installation.

Tuberculosis in the United States

ACCORDING to the *Journal of the American Medical Association* of September 26, the United States National Tuberculosis Association has reported that 44 persons per 100,000 of population died of tuberculosis in 1941, as compared with 46 in 1940. In 1941 the deaths from tuberculosis in the United States amounted to 59,173, and 105,714 fresh cases were reported. The highest tuberculosis death-rate occurred in Arizona (171 per 100,000). Other high rates per 100,000 reported were in the District of Columbia (82), Tennessee (79), Maryland (74), Kentucky (67) and New Mexico (65). The lowest death-rate reported was from Utah (11). Other States with a rate far below the national average were Wyoming (13), Iowa (15), Nebraska (15), Idaho (16), North Dakota (18), New Hampshire (21) and Kansas (22). New York State reported 6,208 deaths —a rate of 45·5.

New Zealand Earthquakes

DURING August 1942, ten strong earthquakes were registered by the seismographs at Wellington, Auckland, Christchurch, Arapuni, New Plymouth and Tuai in New Zealand (*Prov. Bull.* No. P.126, New Zealand Seismological Report; Dominion Observatory, Wellington, N.Z., 1942, August). The earthquake on August 1 was a local shock, namely, the Wairarapa Earthquake, and that on August 29 had an estimated depth of focus near 600 km. Altogether there were twenty-three local shocks felt in New Zealand during the month, of which by far the strongest was that on August 1 at about 12h. 34·1m. U.T. with epicentre near lat. 41·0° S., long. 175·8° E. This was felt from near Auckland to Dunedin and Queenstown, and in parts of Wairarapa had an intensity of rather more than 8 on the Rossi-Forel scale.

History of Science

IN Catalogue 70, Messrs. E. F. Goldsmith and Co., of 45 Old Bond Street, London, W.1, are offering for sale the library of Prof. A. Wolf, formerly professor of the history and philosophy of science at University College, London, and some new acquisitions, amounting in all to 834 items. The catalogue includes works on anthropology, astronomy, biography, biology, botany, chemistry, mathematics, optics, philosophy, psychology and statistics. Among the outstanding volumes are the first edition of "Astronomici Veteres" (1499), Tycho Brahe's "Epistolæ Astronomicæ" (1595), Simon Stevin's "Œuvres Mathématiques" (1634), Scheele's "Chemical Essays" and Volta's "Collezione dell' Opere" (1816). Modern writers are represented by numerous works of Einstein (including his "Brief Outline of the Development of the Theory of Relativity" from the special issue of NATURE on Relativity published on February 17, 1921), Freud, Galton, Karl Pearson and J. J. Thomson.

Announcements

MR. ORVILLE WRIGHT, of Dayton, Ohio, has been elected an honorary member of the Institution of Mechanical Engineers in recognition of his distinguished contributions to mechanical science. Through many years of patient and productive experiment Mr. Orville Wright, with his late brother Wilbur Wright, developed an aeroplane, with wing sections, motor, and controls, which made possible the flight of Orville Wright in 1903.

PROF. G. P. THOMSON, professor of physics in the Imperial College of Science and Technology, is to deliver the May Lecture for 1943 of the Institute of Metals. His subject will be "Electron Diffraction". It is of interest to recall that his father, the late Sir J. J. Thomson, delivered the Institute's May Lecture in 1915, speaking on "The Conduction of Electricity through Metals".

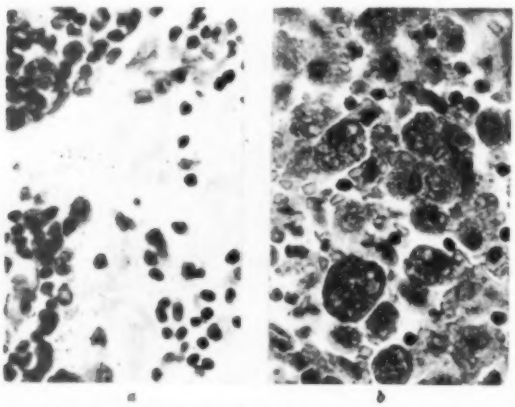
THE Faculty of Science of Marx House, London, organized a symposium on "Science and Technology in the Soviet Union" which was held during April 5 and 6 last (see NATURE, April 18, p. 426, and May 16, p. 545). Articles based on papers presented at these meetings by Prof. J. D. Bernal, Mr. H. P. Vowles, Dr. N. F. M. Henry, Mr. H. Rose, Dr. M. Ruhemann and Mr. J. L. Fyfe have now been brought together in a pamphlet, obtainable from the Organizing Secretary, Marx House, 1 Doughty Street, London, W.C.1, price 2*s*.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Formation of Hæmolymph Nodes in Rats Treated with 1 : 2 : 5 : 6-Dibenzanthracene

PREVIOUS investigators[1–4] have described the spontaneous occurrence of hæmolymph nodes in the rat. As a rule, two nodes situated in the vicinity of the kidneys were found to be the most conspicuous representatives of these structures. Their histological features were studied in detail by these workers; but much uncertainty exists as to the origin and possible function of such nodes, and the same applies to those observed in other species of mammals. It is obvious that useful information might be obtained from experiments aiming at the conversion of ordinary lymph nodes into hæmolymph nodes, and our investigations in this field have led to a number of



PART OF THE CENTRAL SINUS OF A CERVICAL LYMPH NODE. *a*, from a control rat; *b*, from a rat treated with 1 : 2 : 5 : 6-dibenzanthracene. Hæmatoxylin. × *c.* 340.

results, some of which appear to be conclusive. This note describes the effect produced in the lymph nodes of rats by treatment with the carcinogenic hydrocarbon 1 : 2 : 5 : 6-dibenzanthracene, the experiments being suggested by previous observations on rats treated with carcinogenic tar[5].

The hydrocarbon was administered in an aqueous colloidal solution, 27·8 mgm. (that is, 0·1 milli-mole) being dispersed in 100·0 c.c. of a solution of 5·6 per cent glucose and 0·5 per cent gelatine. 1·0 c.c. of this liquid was injected subcutaneously into a series of male pre-adult rats usually five times weekly for a period of about four weeks. This treatment was on the whole well tolerated. For comparison, other rats of similar weights were treated with a control solution (glucose-gelatine medium only), injected in a corresponding manner.

It was found that while the lymph nodes from the control rats were throughout of normal appearance, a number of the lymph nodes from the dibenzanthracene-treated rats showed a red or brownish-red discoloration on their surface, varying in extent and degree. A hæmolymphatic transformation of these nodes was thus indicated. The change occurred in all regions of the body; its intensity—as regards the number of affected nodes and the amount of discoloration in individual nodes—tended to increase with the duration of treatment, and appeared to be even greater some time after its termination. On microscopical examination, the following principal changes were observed in the structure of these nodes, as compared with the nodes from control animals: (1) a more or less distinct widening of the lymph spaces and corresponding diminution of the lymphatic tissue; (2) the presence in these lymph spaces of red blood corpuscles, frequently in considerable numbers; (3) an increase in the number of free macrophages loaded with red blood corpuscles and a greenish-brown pigment which, on applying the microchemical test for free iron, proved to be 'hæmosiderin'. From the latter findings it is evident that the red cells present in the lymph spaces undergo a process of destruction. An illustration of these histological changes (stated under 2 and 3) is given by the two accompanying photomicrographs, taken at high magnification. Part of the central sinus of a cervical lymph node is shown in each, (*a*) referring to a control animal and (*b*) to a dibenzanthracene-treated animal. It will be seen that in (*a*) the cell content of the sinus is confined to a number of lymphocytes and reticular cells, while in (*b*) the sinus contains in addition many red blood corpuscles as well as a number of free macrophages carrying blood corpuscles and pigment. It is to be noted that the histological changes thus observed agree essentially with the histological features of the renal hæmolymph nodes occurring already in control rats.

A detailed account of this work will be published elsewhere. Further investigations are in progress regarding the possible action of two other carcinogenic hydrocarbons (3 : 4-benzpyrene, methylcholanthrene) and two related non-carcinogenic hydrocarbons (anthracene, phenanthrene), both groups of substances being employed in a similar manner to 1 : 2 : 5 : 6-dibenzanthracene. So far, it has been found that hæmolymph nodes can be formed in rats treated with either of the two carcinogenic hydrocarbons, while no appreciable changes seem to occur in the lymph nodes of rats treated with either of the two non-carcinogenic hydrocarbons. These results, if confirmed by subsequent work, might indicate that the ability of a polycyclic hydrocarbon to produce hæmolymph nodes in the rat is in some way connected with its ability to produce cancer.

A. LASNITZKI.
D. L. WOODHOUSE.
Departments of Physiology and Pathology,
University of Birmingham. Nov. 12.

[1] Vincent, S., and Harrison, H. S., *J. Anat. and Physiol.*, **31**, 176 (1897).
[2] Drummond, W. B., *J. Anat. and Physiol.*, **34**, 198 (1900).
[3] Lewis, Th., *Internat. Monatsschr. Anat. und Physiol.*, **20**, 1 (1903).
[4] Macmillan, R. E., *Anat. Rec.*, **39**, 155 (1928).
[5] Lasnitzki, A., *J. Hygiene*, **38**, 392 (1938).

Partial Purification of Cell Growth-Promoting Principles in Adult Tissue Extract

IN a previous note from this Laboratory[1], it was reported that extracts of heterologous adult tissues possess the ability to stimulate *in vitro* the growth of various cells including human epithelium, and the use of adult tissue extracts in wound treatment was suggested. We report below the results of experiments

carried out to purify the growth-promoting principles present in adult tissue.

Minced heart muscle of sheep or fowl was extracted with five parts of physiological saline solution and the extract precipitated with four volumes of 96 per cent alcohol. The precipitate was centrifuged and then dried over calcium chloride *in vacuo*. The dry product represents about 5 per cent in weight of the original material. It is slightly soluble in Ringer, better in Tyrode, and more readily in 0·01 *N* ammonium hydroxide. The growth of fibroblast cultures in a medium to which the solution of the alcohol precipitate in Tyrode is added is stimulated to the same degree as the growth of cultures treated with the original heart muscle extract. Repeated extraction of the dried alcohol precipitate with either acetone, ether or petroleum ether led to improvement of the stimulating power. Dialysis of solutions of the alcohol precipitate against Ringer did not affect their activity.

An ammonia solution of the alcohol precipitate was neutralized and precipitated by half-saturation with ammonium sulphate. The sediment was dissolved in dilute ammonia, carefully dialysed, and the solution evaporated *in vacuo* to dryness. The product thus obtained was almost entirely soluble in Tyrode and displayed good growth-promoting properties.

These experiments are only a first step. Nevertheless, their publication seems desirable, as during the course of this work alcohol precipitates possessing great cell-promoting power have been obtained. These preparations may represent a particularly appropriate material for experiments in wound healing. It combines with high potency the following practical merits: its preparation does not require sterile precautions except at the final stage; its storage is convenient and its stability is unlimited.

H. WERNER.
L. DOLJANSKI.
Department of Experimental Pathology
(Cancer Laboratories),
The Hebrew University,
Jerusalem.

[1] NATURE, **150**, 23 (1942).

Preservation of Plant Material

PRESERVATION of botanical material for teaching purposes is frequently necessary and is commonly achieved by keeping the material in alcohol. With whole plants, or bulky organs, for example many succulent fruits, large quantities of alcohol are required.

Satisfactory preservation may be obtained with many types of material by using a solution of sulphur dioxide, and this method has much to recommend it on the scores of convenience and economy. The use of sulphur dioxide as a preservative of fruits and fruit products for domestic and industrial use is well known. For domestic use "Campden Tablets", consisting of sodium or potassium metabisulphite, may be employed, each tablet as purchased containing the equivalent of 4 grains of sulphur dioxide, so that when dissolved in water (½ pint or 10 oz.) a solution containing approximately 0·1 per cent sulphur dioxide is obtained. This solution preserves most succulent fruits required for morphological studies satisfactorily. It has also proved adequate as a preservative of material required for anatomical work by elementary classes. Any slight hardening effect of the solution is not a disadvantage when herbaceous material is employed, and sections of the preserved material stain normally with common stains such as aniline chloride, iodine and phloroglucin. Anthocyanin pigments present are 'bleached' by the solution, but the blackening to which some plants, for example broad beans, are prone is prevented.

Directions for the use of the "Campden Tablets" include instructions to cork the bottle tightly, and to seal with wax. In fact, tight corking is generally sufficient, but frequent opening of the container in order to remove material is not permissible, as this allows oxidation of the sulphur dioxide and subsequent growth of mould. This is not a disadvantage when preservation of material for use on a subsequent single occasion is required, and even this trouble might be obviated by the addition of a tablet of preservative whenever the bottle has to be opened. Occasionally with fruits containing little free acid slight fermentation occurs[1] but fruits, flowers, stems and leaf material in freshly made solution, and in tightly corked containers, have all kept satisfactorily here.

In field use the method is convenient as the tablets are easily carried, and bottles of ½ pint (10 oz.) capacity or some multiple of this are obtainable in almost every locality and need only to be filled with water and tablets added at the rate of one to each ½ pint of water.

Clearly the adoption of this method of preservation results in the saving of an appreciable amount of alcohol, and at present this alone may well outweigh slight disadvantages that the method possesses.

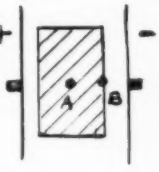
L. G. G. WARNE.
Botanical Department,
The University,
Manchester, 13.
Nov. 5.

[1] Crang, A., "Preserving Fruits with 'Campden' Fruit Preserving Tablets". Ann. Report Agric. and Hort. Research Station, Long Ashton (1941).

Validity of the Clausius-Mosotti Formula

IN a paper published in 1940[1] I threw doubt on the validity of what is now called the Clausius-Mosotti formula and put forward another which, if correct, would considerably affect present values of the dipole moments of many substances.

In that paper I stressed the confusion between macroscopic and microscopic treatments of the problem. The difficulty may, perhaps, be seen more clearly from the following treatment of the usual case of a plane slab of polarizable material placed in the uniform field of a charged condenser as shown in the figure.



Consider the alternative cases, (1) the molecules are uniformly polarized; (2) the molecules are not uniformly polarized.

(1) If the molecules are supposed all uniformly polarized (and this can be proved only on the macroscopic view), there is no difference between the polarizing field at A and that at the boundary B. There is therefore no need to calculate the force E at A and say that, if the polarizability is α, then the moment of a molecule at A is αE. The moment at A is the

same as at B, and as B is on the boundary, this moment contributes to Poisson's Layer of surface density σ. If there are n molecules per cm.^{3} we have at once

$$\sigma = \text{electric moment per unit volume} = n\alpha E.$$

To relate this result to what is actually measured, namely, the drop in potential when the slab is introduced, we imagine a channel cut through the dielectric so that a unit positive charge may be taken from one plate to the other through it. If E_A is the intensity before the dielectric is inserted, the force in the channel is $E_A - 4\pi\sigma$, and experiment shows that this must be assumed to be E_A/K, since the potential drops to $1/K$ of its vacuum value, where K is the dielectric constant. Thus:

$$E = E_A - 4\pi\sigma = E_A/K = \sigma/n\alpha, \text{ whence } K = 1 + 4\pi n\alpha.$$

(2) If the molecules are supposed not uniformly polarized (and this must be the case on a microscopic view, since the polarizing force at A must differ from that at B owing to the different arrangement of surrounding molecules), then Poisson's volume distribution of charge must be taken into account as well as the surface layers in order to calculate the force at the centre of a spherical cavity. This is never done, and it could not be done for lack of information as to how the polarization varies from point to point. The treatment which Clausius gave is therefore not valid.

The conclusion seems to be that only a macroscopic treatment can be applied and that the formula should be

$$K = 1 + 4\pi n\sigma.$$

Thus for the molar polarization P we should have

$$P = \frac{K - 1}{3} \cdot \frac{M}{\rho}$$

instead of Clausius-Mosotti

$$P = \frac{K - 1}{K + 2} \cdot \frac{M}{\rho}$$

(M is molecular weight, ρ is density).

G. Burniston Brown.

University College of London,
at University College,
Bangor.
Nov. 8.

[1] Brown, G. B., *Proc. Phys. Soc.*, **52**, 577 (1940).

Shape of Subjective Space

The apparent alteration in the size and shape and spatial relation of objects when right-eye and left-eye viewings are interchanged (or in other way the binocular parallax is reversed) may prove to some degree dependent on retinal structure, as suggested by Mr. Cox[1], but considerable alterations of like character are certainly accounted for by peculiar geometrical conditions, in conjunction with extreme quickness of the eyes and mind to interpret these as normally as possible.

More than ten years ago, I directed general attention to the astonishing effect of viewing the Hyades or Orion's Belt, or similar bright star group, through a common inverting binocular, when the stars are behind a familiar object like the bare twigs and branches of a tree, or the figure of a man, a little way off. To most observers with normal sight the stars appear in the air half-way to the tree, which in some cases may mean only a yard away through the binoculars. That provides or points out the general illustrative kind of case for such phenomena, even for the naked eyes, though the effects are rather feebly noticeable at long distances when telescopes are not used.

Briefly, explanations of the half-way appearance may be arranged like this: The distance d of the tree is assessed at once, in the ordinary view, by convergence (so far as the distance is short) and by the angular subtense which the tree shows as a chosen familiar object. After the reversal of parallax there is no natural convergence at all to use (only eye-straining divergence), but most observers still assess d well enough by the angular subtense. The ordinary relative parallax of the tree and heavens is like $\frac{1}{d} - \frac{1}{\infty}$. After reversal it is similarly like $\frac{1}{x} - \frac{1}{d}$, where x is the apparent distance of the heavens, a distance now less than d because of the reversal. Of course $\frac{1}{x} - \frac{1}{d} = \frac{1}{d} - \frac{1}{\infty}$, so $x = d/2$, and that the eyes and mind instantly recognize, after their lifelong experience of similar parallax problems. Only to the extent the object is not familiar, or not single and distinct but confused, may the observer not promptly recognize d, and then it is that the heavens are found reluctant to leave their usual remoteness. The telescopes of magnification m make x as small as $d/2m$; and they also aid by their ordinary telescopic flattening of the tree. The interchange of the far and near parts of the tree is curious but not very important. When the sun (or moon) is in view with the tree, the linear diameter of the sun appears as small as $d/230$ feet, which is sometimes as little as two or three inches. Intrusive twigs make a transparency effect.

It is evident that the subjective spatial change in this example is remarkable. The whole universe has in effect been turned inside out at the dictate of the tree and its scale-fixing distance d. The outermost parts towards infinity have been brought in to a spherical surface of only $d/2m$ ft. radius around the observer, and parts nearest the observer have been dispersed towards infinity. Accordingly, to some observers in clear air over a featureless plain, dozens of men ranged in line from as near as the tree, outwardly to the horizon, appear as dwarfs near at hand tapering outwards to become giants in the distance. Perhaps because the dwarfs are more crowded, numerous and uninteresting, normality usually seems allotted to them, and magnification is declared the chief impression. Possibly causes of similar kind might be found involved in some of the magnification effects which have come under Mr. Cox's notice.

The mind's instant, unhesitating use of the eyes and former experiences, or memory, as instruments in these subjective phenomena is noteworthy. The geometry and the eyes cannot prove the whole of the interest. In that connexion, regard should certainly be had to Sir Richard Paget's communication in Nature of July 22, 1939, p. 153.

S. L. Walkden.

58 Raleigh Road,
London, N.8. Nov. 16.

[1] Nature, **150**, 349 (1942).

RESEARCH ITEMS

Schooling of Mackerel

ARTHUR SCHLAIFER has made some interesting experiments ("The Schooling Behavior of Mackerel: A Preliminary Experimental Analysis". *Zoologica*. Scientific Contributions of the New York Zoological Society, **27**, Part 2, No. 14; 1942). These were carried out at the Woods Hole Station of the U.S. Fish and Wildlife Service. The fishes used were 8-in. specimens of the chub mackerel, *Pneumatophorus grex* (Mitchell), caught in the waters off Woods Hole and afterwards kept in large tanks in the laboratory. It was found that two individuals suffice to form a school, swimming always in line with each other. If one mackerel is kept isolated and another is put in with it, the two immediately school and any others added join them. Schooling is seen still better in larger groups. Blinding, darkness and visual contact experiments indicate that the schooling reaction of the mackerel is visually integrated. Mackerel display no schooling reaction to others of the same species, dead or alive, which move or are moved in a manner not completely normal. Apparently there is no response to body colour. Isolation for three weeks does not eliminate or reduce the schooling proclivity. Good photographs are given of mackerel in fairly strong artificial light, in total darkness and in light in the deep red end of the spectrum.

Biology of a Carnivorous Snail

WILLIAM MARCUS INGRAM gives some interesting notes on *Euglandina rosea*, a well-known species common on the sea islands of Georgia and around the Keys of Florida ("Food, Eggs and Young of the Carnivorous Snail *Euglandina rosea* (Férussac)". *Zoologica*. Scientific Contributions of the New York Zoological Society, **27**, Part 2, No. 15; 1942). A specimen was kept in a terrarium and laid eggs there. Experiments in feeding resulted in its eating the molluscs *Mesomphix inornatus* and *Anguispira alternata*, leaving untouched another species of Mesomphix, *M. cupreus*, and young and adults of *Triodopsis albolabrus*. It is evident that there is definite selection here. The method of feeding is described, the snail devouring the whole of the living prey from inside the shell. When completely inert it reacted directly to the food selected, and although ten inches away it was moving towards it within three minutes. All the molluscs eaten were first turned over on their apices. Twenty-two eggs, laid on the upper surface of the humus in the terrarium, exposed to the light, were about 3 mm. in length with hard calcareous shells. The approximate incubation period was 60-68 days, when the young broke through the shell by means of the radula.

Germ Cell Inclusions

THE investigations into the cytoplasmic inclusions in the germ cells of the mouse by Dr. R. A. R. Gresson have been continued in two further publications. One deals with the inclusions found during the maturation, fertilization and first cleavage division of the ovum (*Quart. J. Micro. Sci.*, **82**, Pt. 4; 1942) and the other with those found during spermatogenesis (*Proc. Roy. Soc. Edin.*, B, **61**, Pt. 2; 1942). The Golgi elements appear to be fairly evenly distributed throughout the period from maturation to the formation of the first two blastomeres. The mitochondria are most numerous in the central region during maturation divisions, a few being eliminated with the polar body. During the stage of the pronuclei they concentrate in the neighbourhood of these structures and they congregate around the first cleavage spindle in such a manner that they are distributed approximately equally to the two blastomeres, where they gather into small clumps and are then scattered singly throughout the cytoplasm. In the spermatogonia and spermatocytes the Golgi elements are situated at one pole of the nucleus; during division they remain near the equatorial region of the nucleus and either as two clumps or dispersed they are distributed to the daughter cells. In the young spermatids they are applied to the anterior pole of the nucleus but move away, leaving a vacuole, later filled by the acrosome, then bud off a small portion which moves to the posterior pole and this is later included in the middle piece of the sperm. The spherical mitochondria are most numerous in the neighbourhood of the nucleus in spermatogonia and spermatocytes, and in the transformation of the spermatid into the spermatozoon most of them come to lie around the axial filament. The sperm enters the ovum at the anaphase of the second maturation division.

Parasites of Horses

A USEFUL account of the nematode parasites of the horse belonging to the family Strongylidæ as of Baird 1858 is furnished by Dr. W. A. Rosa and Dr. E. J. Galofre (*Inst. Parasit. Enfer. Parasit. Univ., Buenos Aires*, **1**, Fasc., 6; 1940). The 19 species treated are divided among four genera: Strongylus 3 spp., Triodontophorus 2 spp., Trichonema 13 spp., and Gyalocephalus 1 sp. The introductory portion consists of a good general account of the anatomy and classification of the family. The remainder of the paper consists of a series of plates, one for each species, of drawings to scale of the diagnostic and comparable parts of both sexes of the strongyles. The plates are accompanied by fully annotated explanations and measurements, so that it should render the identification of any of the species comparatively easy.

Genetics of the Sorghums

IN a series of notes originating from the Millets Breeding Station, Coimbatore, G. N. Ayyangar and various co-workers describe the mode of inheritance of a number of characters in the Sorghums (*Current Science*, pp. 491, 492, 528 and 533; 1941). One of the most interesting is a dominant mutation for purple anther base (A_b), detected in the heterozygous condition in *Sorghum dochna* and later found to be due to a single gene closely associated with one of the two *B* genes for brown pericarp colour. The independent genes C_1 and C_2 behave as simple dominants and deepen the light green of normal lines, thus accounting for the dark green (C_1C_2), green (C_1c_2 or c_1C_2) and light green (c_1c_2) noted in the blocks of plants forming the World Collection of Millets at Coimbatore. The curious habit of 'goose-necking' (bearing heads on recurved stems) shown by some of the Sorghums is brought into line with genetical observations. The recessive gene w_y results in a wavy peduncle to the inflorescence: this condition in a plant having a naturally short peduncle causes the ear to twist and escape out of the side of the last leaf (the 'boot') and so become bent into a 'goose-neck'. The relatively rare long type of hairs

found on the glumes of *S. dochna* var. *burmanium*, *S. Roxburghii*, *S. caffronum*, *S. coriaceum* and *S. cernuum* are described as due to an independent dominant gene *Gf* which lengthens the hairs produced by the gene *Gh* for the normal hairy condition. *GfGh* results in long hairs, *gfGh* the normal hairy condition and *Gfgh* or *gfgh* 'glabrous'.

Structure of Urea and Thiourea

PREVIOUSLY reported values for the dipole moment of urea (8·6) and thiourea (7·6) are unexpectedly high in comparison with those of related compounds, and these constants have been redetermined in dioxane as solvent at 25° by W. D. Kumler and G. M. Fohlen (*J. Amer. Chem. Soc.*, **64**, 1944; 1942), who find the values 4·56 and 4·89, respectively, which fall in line with those of similar compounds. The molecules were not associated in these solvents. The results throw some light on the old controversy as to whether urea and thiourea are amphions. This was at first taken to imply the structure $\bar{O}-C\begin{matrix}\diagup NH \\ \diagdown NH_2+\end{matrix}$ but later $\bar{O}-C\begin{matrix}\diagup NH_2+ \\ \diagdown NH_2\end{matrix}$, involving a separation of charge but no proton transfer, and thus a resonance hybrid. The moderate values of the dipole moments show that such structures do not contribute predominantly to the state of the molecule. The short C to N distance has been supposed to indicate an amphion structure, but this amounts only to about 20 per cent of double bond character. The fact that the ratio of the solubility of urea in alcohol to its solubility in water is much higher than for an amino-acid with an amphion structure also makes such an ion structure in alcohol improbable. It seems as if everything can be accounted for by about 20–30 per cent of amphion structure, the essential structure of urea and thiourea being that of simple amides except for a somewhat larger contribution of the forms with a separation of charge.

Structure of Galactic Clusters

GEORGE ALTER has a paper on the structure of galactic clusters (*Mon. Not. Roy. Astro. Soc.*, **102**, 4) deducing a number of important tentative conclusions. He starts by assuming that the structure of a galactic cluster depends on the development of the cluster, which is of two kinds: (*a*) the dynamical evolution of the whole unit; (*b*) the spectral evolution of the individual members. Trumpler proposed a hypothetical evolution of clusters, which was based on a detailed classification according to the presence of yellow or red giant stars and the earliest star type within the cluster, and Alter simplifies this by a regrouping into four classes. It is suggested that clusters develop from the giant cool class through the giant hot and main hot to the main cool class, but with a certain indeterminacy near the central classes, where short transitions may occur. From a number of tables it is shown that the relations between these four classes and various structural properties of galactic clusters support the suggested scheme of classification. It is believed that the clusters develop along a life-line similar to that of the Russell diagram, and during this evolution the clusters are subject to the influence of the galactic field. The initial volume of 10–100 cubic parsecs increases until disintegration leads to the loss of stars merging with the surrounding star field. The lowest recognized average spatial star density within a cluster is about five times that of the star density in the vicinity of the sun, and the highest is about 250 times as much. The true values are actually higher, and this is explained by the star numbers used for determination being restricted by the magnitude limit of the photograph. The largest observed volume is about 1,000 cubic parsecs.

Voltage Surges Caused by Contactor Coils

A PAPER on this subject by J. R. Taylor and C. E. Randall, read before the Institution of Electrical Engineers, discusses the phenomena associated with the switching of contactor coils, particularly with reference to the effects of 'switching peak' voltages on insulation and switch contacts. The effect of circuit layout on the switching peaks and the arcing of contacts is described, together with methods of reducing the severity of these effects. Owing to a series of insulation breakdowns, it was decided to make an investigation of the switching-off voltages of a D.C. contactor coil. Early experiments were merely qualitative, but later, equipment was built for quantitative tests. Photographic records of the various phenomena were made in order to give a clear picture of the different conditions which are met. Peak voltages up to ten to fifty times the supply voltage occurred. Eventually it was decided to extend the research to A.C. contactor coils, and peak voltages up to five to six times the mains voltage peak were found to occur under favourable conditions. It is obvious from the tests that clearances which are satisfactory for electric lamps on 230 volts are totally inadequate for coil circuits even on 100 volts, and that on higher voltages it is essential to have large clearances and creepage distances. Instances are known of sparks jumping distances of as much as ½ in. along the surface of slate on control panels connected to 530-volt tramway supplies.

Grid-Controlled Mercury-Arc Mutators

R. FEINBERG, in a paper entitled "Static Conversion of Direct Current to Alternating Current with Grid-Controlled Mercury-Arc Mutators" (*J. Inst. Elec. Eng.*, **89**, Pt. 1, No. 22; October 1942), deals with the theory of the push-pull mutator invertor, which is a D.C. arrangement with grid-controlled mercury-arc mutators operating alternately and causing an alternating current to flow in the load circuit. In the case of resistance load, practically any shape of alternating voltage wave-form between rectangular form and triangular form can be produced. The shape of the alternating voltage wave-form depends upon the capacitance of the invertor capacitor, a relatively small capacitance giving the alternating voltage a rectangular form and a large value making it triangular. The ripple factor of the direct current is governed by the smoothing effect of the inductance in the D.C. circuit, a small inductance causing the direct current to flow intermittently. The degree of regulation of alternating voltage at any change of load is determined by the capacitance of the invertor capacitor. A large capacitance may produce such a large voltage regulation that the curve of power output plotted against load describes a V form, the power output being increased when the load is reduced. The invertor stops working when overloaded. Calculations are given for approximate circuit conditions, and the results of experiment have been found to agree satisfactorily with the theory.

MEDAL AWARDS OF THE ROYAL SOCIETY*

Copley Medal

THE Copley Medal has been awarded to Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford.

Sir Robert Robinson is recognized in all countries as one of the world's leaders in organic chemistry, and is one of the greatest and most versatile of investigators in that department of science. His researches, with a long and notable succession of pupils and collaborators, have covered a remarkably wide range of problems in this field, and his approach to these has been distinguished by brilliance in conception and a genius for the selection of methods leading to the desired solutions. Robinson's investigations have been particularly concerned with the chemistry of natural substances, products of the life processes of plants and animals. His work has thus been a potent factor in the tendency of organic chemistry to return, in recent years, to an objective nearer to that of its origin, and to make contacts of growing intimacy and value with biochemistry, a more recent development in response to the stimulus of functional biology.

This occasion does not permit any attempt at a complete or detailed survey of all the different fields which Robinson's work has illuminated and opened to further exploration. Special mention must be made, however, of his long series of fundamental investigations on the constitution and relationships of the plant alkaloids. His theory of the biogenesis of plant products seems rather to have inspired than to have resulted from his own early and elegant synthesis of tropinone; and it has revealed an unforeseen and coherent relationship between the constitutions of different groups of alkaloids, and given a great stimulus to work on their synthesis. The work published from Robinson's laboratory has been fundamental to understanding of the isoquinoline and the indole series of alkaloids, of morphine and its allies, and of the structural formulæ of strychnine and brucine, which formed the subject of his Bakerian Lecture.

Of at least equal scientific rank is the work which Robinson carried out and inspired over many years on the anthocyanin and, more recently, on the anthoxanthin pigments of plants, culminating in the synthesis of the actual colouring matters of flowers, and forming as a whole one of the most brilliant achievements in the whole range of modern organic chemistry.

Robinson's mastery of synthetic resources, and his penetrating instinct for clues to organic constitution, have been further demonstrated in a more recent approach to the synthesis of the steroids, in the production of series of compounds of interest for chemotherapy, and in notable studies of individual natural substances of a range of other types. He is, moreover, a philosopher as well as a master of experimental possibilities; and his theory of organic reactions, in the modern, electronic terms of valency bonds, has had a great influence on the development of fundamental conceptions in organic chemistry.

The Copley Medal is the highest recognition of scientific achievement in the Royal Society's gift, with no limitations of subject or nation; and the Society may well find cause for satisfaction in the knowledge that the award of its premier medal, this year for achievement in organic chemistry, after an interval of many years, finds among its own fellows a recipient of such unquestioned pre-eminence as Sir Robert Robinson.

* Remarks made by Sir Henry Dale, Pres.R.S., in presenting the medals for 1942.

Rumford Medal

The Rumford Medal has been awarded to Dr. G. M. B. Dobson, reader in meteorology in the University of Oxford.

The Rumford Medal awarded by the Royal Society was established for the recognition of important discoveries made in Europe, especially on heat or on light. These conditions appear to be met with a special fitness in the award of the Medal this year to Dr. G. M. B. Dobson, for his meteorological researches and discoveries. For Dobson's work has, in recent years, greatly extended knowledge of the linkage between the behaviour of ozone and cyclonic disturbances, in that complicated heat engine which is the earth's atmosphere; while light may be said to have provided the basis of measurement for Dobson's spectrographic studies of the distribution of ozone, in time and in height above the earth's surface.

Light had also a major concern in earlier researches on meteors in which Dobson collaborated with Prof. F. A. Lindemann (Lord Cherwell); in these, the study of the heights between which meteors become luminescent enabled them to draw conclusions as to the density, and from these as to the temperature of the atmosphere at great heights from the earth's surface. But it is especially on Dr. Dobson's own studies of the ozone of the atmosphere, continued over many years, and producing results of outstanding importance for meteorology, that the award is based.

Royal Medals

A Royal Medal has been awarded to Prof. W. N. Haworth, professor of chemistry and director of the Chemistry Department in the University of Birmingham.

Haworth's great claim to distinction arises from the revolutionary change which has been produced by his own investigations, and by those of his immediate pupils, in the whole aspect of an important section of organic chemistry, dealing with the structure and the relationships of the carbohydrates. The ring structure of the simple sugars, first proposed by Tollens and supported by the work and the authority of Emil Fischer, had been generally regarded by chemists as firmly established. Detecting insecurities in the arguments which led to this formulation, Haworth developed the methylation technique, first used by Purdie and Irvine, and applied it systematically to the monosaccharides. He was thus able to show, by unequivocal methods of organic chemistry, that the accepted ring structure of these sugars was incorrect, and that, in their normal and reactive forms, they were derivatives of pyran and of furan respectively.

Later, Haworth further developed his methods in application to sugars and carbohydrates of increasing complexity. By his work, and that of others who have followed his lead, the detailed structures of many disaccharides and of some trisaccharides have been established. Progress has further been made in his attack on the structural complexities of the polysaccharides, and a simple chemical method has been evolved for determining their minimal molecular

weights. Prof. Haworth's work, in the field which he has thus made his own, has received the high international recognition of a Nobel Prize, and will assuredly take rank as a major achievement of permanent significance in chemical history.

A Royal Medal has been awarded to Dr. W. W. C. Topley, formerly professor of bacteriology and immunology, University of London, now secretary to the Agricultural Research Council.

Dr. Topley is one of the most distinguished of the British bacteriologists of recent years. The most important of Topley's contributions to bacteriology and experimental medicine has been the experimental study of epidemics, which he initiated and of which the methods have been largely his own creation. Much had been learned by the statistical analysis of observational data, dealing with the origin, spread and development of natural epidemics, under conditions largely out of control. Topley conceived the idea of applying such methods to the investigation of epidemics started artificially in populations of healthy mice, kept in the laboratory under conditions which could be exactly controlled and deliberately varied. Thus the factors conducive to the rise, culmination and decline of an epidemic, to its revival or its final subsidence, could be experimentally determined. In a long series of such studies, the important results of which were reviewed in his Croonian Lecture for 1941 on "The Biology of Epidemics", Topley had the statistical co-operation of Prof. Major Greenwood, in both planning and interpretation.

On this firm basis of knowledge concerning the incidence and mortality of a naturally transmitted infection in untreated stock, the efficiency of prophylactic measures could be put to a controlled test. Under Topley's guidance and inspiration, accordingly, substantial progress has been made by his chemical colleagues towards the isolation from various species of pathogenic bacteria of highly purified and stable antigens, and the practical trial of some of these was interrupted by the outbreak of war.

Dr. Topley's researches have had a great and lasting influence on the study of bacteriology, immunology and epidemiology in relation to human medicine. His recent change of the focus of his interests may be expected to give an important stimulus to advance in many cognate fields of agricultural research.

Davy Medal

The Davy Medal has been awarded to Prof. C. N. Hinshelwood, Dr. Lee's professor of chemistry in the University of Oxford.

The award has been made for Prof. Hinshelwood's work on the kinetics of chemical change, characterized by its pioneering quality and by the varied new lines of research which it has opened up. An experimental investigator of great skill and achievement, Hinshelwood has also enlarged the theory of the subject by able mathematical analyses and descriptions based on the concepts of collisions and of activation energy.

Hinshelwood took a leading part in the early study of homogeneous gaseous reactions. As the result of the examination of a number of bimolecular examples, he was able to show, with reason, that these are confined to molecules containing few atoms, and that the actual rate was given by the product of the total collision rate and the probability of a molecule possessing the experimental energy of activation. Unimolecular reactions were found to occur with polyatomic molecules and to show more complex features. In association with Prof. F. A. Lindemann (Lord Cherwell), Hinshelwood put forward the mechanism, now accepted, whereby a reaction fundamentally dependent on collisions may nevertheless have unimolecular kinetics. This theory he was able to verify by showing that the rates of such reactions diminish at low pressures and that the kinetics then become bimolecular.

In the field of chain reactions Hinshelwood opened up new lines of advance by studying the thermal reaction between hydrogen and oxygen. Thus he discovered, and offered clear explanations for, the curious phenomenon of 'explosion limits', confining explosive reaction, at any fixed temperature, sharply to a particular pressure region. Elaborate studies of the effects of nitrogen peroxide and other foreign gases on the hydrogen–oxygen reaction brought to light the very great kinetic complexities of an apparently simple type of chemical change. In this work Hinshelwood directed attention to the influence of the container surfaces on chain reactions, and also clarified the confusion of evidence concerning the effects on reaction rates of the intensive drying of gases. His discovered the inhibition of certain gaseous reactions by nitric oxide and interpreted the effect as due to the removal of radicals from, and the suppression of, 'chains'.

Hinshelwood has also carried out a large number of experiments on heterogeneous reactions and shown that their differences in kinetic behaviour can be explained by the application of the concepts of Langmuir.

Throughout all these researches, carried out with the utmost economy and directness, though with full experimental precautions, and interpreted in the most lucid manner, Hinshelwood has never lost sight of the essential complexity of chemical reaction mechanisms. He has always been ready to modify his views in accordance with new experimental evidence, and to make the fullest use of the more recent developments of wave-mechanics and of statistical mechanics. Summarized by their author in two well-known treatises, Prof. Hinshelwood's distinguished researches furnish abundant ground for the award to him of the Davy Medal.

Darwin Medal

The Darwin Medal has been awarded to Prof. D. M. S. Watson, Jodrell professor of zoology and comparative anatomy at University College in the University of London.

Prof. Watson is pre-eminent among palæontologists for his contributions to knowledge of the course of vertebrate evolution. His researches have been concerned mostly with the origin of the land vertebrates, with the fishes most nearly related to them, and with the main line of evolution leading to the mammals.

It will not be possible to survey here Watson's work in all its aspects, and mention must be restricted to some of the major lines of advance which it has opened. His Croonian Lecture, in 1925, summarized the conclusions which he had reached by that date as to the evolution of the Amphibia, demonstrating for the first time the relationship of the Stegocephalia to the Osteolepid fishes. In addition to tracing the descent of land vertebrates thus from Amphibia back to fishes, Watson followed the line of the evolution of the mammals, through early, primitive reptiles, the Cotylosaurs, to the mammal-like reptiles, in a large series of valuable papers. He related this work on the reptiles to that on the amphibians in a paper on the evolution of the shoulder girdle of the Tetrapoda.

In this work on the fossil vertebrates, in its relation to the course of evolution, Watson has not confined his attention to morphological details, but, with an enterprise remarkable in a palæontologist though characteristic of his outlook, has considered where possible the functional significance of the structures preserved in the rocks; thus he has considered the mode of action of the shoulder girdle and deduced the nature of the musculature of a group of marine fossil reptiles.

Pursuing his study of mammalian origins, Watson was led to study the most primitive of living mammals, the oviparous Monotremes, and to discover that characters in which their skulls differ from those of other mammals can be regarded as extreme developments of features observed in the skulls of certain fossil, mammal-like reptiles.

Watson's work has continued in full vigour into recent years, and has brought two further contributions of major importance to the study of evolution in the vertebrates. One is concerned with the origin of the frogs from more primitive amphibian types, while the other shows that a group of fishes from the Old Red Sandstone constitutes a separate class of vertebrates, equal in rank to and ancestral to the remaining fishes.

Tracing, in this brilliant series of researches, the main stages of the descent of the mammals from their earliest fish-like ancestry, Prof. Watson has certainly performed "work of acknowledged distinction in the field in which Charles Darwin himself laboured".

Buchanan Medal

The Buchanan Medal has been awarded to Sir Wilson Jameson, formerly dean of the London School of Hygiene and Tropical Medicine and since 1940 the chief medical officer to the Ministry of Health and the Board of Education.

In both capacities Jameson has shown himself to be a man of stimulating influence and leadership, determined and persistent in his efforts to ensure that advances of medical knowledge in the laboratory, the clinic and the field shall receive prompt application in administrative practice.

Largely to Jameson's vigorous policy is due the hope that active immunization against diphtheria, which has banished the disease from many large communities of North America, will at length find systematic and effective application in Great Britain, where many of the discoveries were made which have rendered it safe and practicable. In the prompt official adoption of methods using modern technical resources to deal with the recent increase of tuberculosis under war conditions, and in the recognition of adequate and scientifically planned nutrition of the people as a central item of an effective health policy, Jameson's active and enlightened influence can again be discerned.

Of the grounds on which the founder of the Buchanan Medal desired the awards of it to be made, Sir Wilson Jameson's high claim to it is based on "administrative and constructive work" of outstanding merit in the service of hygienic science.

Hughes Medal

The Hughes Medal has been awarded to Prof. Enrico Fermi, now of New York.

Prof. Fermi has made most notable contributions both to theoretical and experimental physics. In the early days of the modern quantum theory he was one of the first theoretical physicists to appreciate the generality of the considerations put forward by Pauli and known as the 'exclusion principle'. This led him to discuss the statistical theory of a perfect gas of particles in equilibrium, obeying this principle, with results which were obtained independently and almost simultaneously by Dirac by similar methods. These results of Fermi and Dirac are of the utmost importance in the modern theory of assemblies of similar particles, such as electrons, protons, and neutrons. Following this outstanding personal contribution, Fermi played a great part in building up at Rome a distinguished school of theoretical physics, where he himself made one of the earliest successful attempts to construct a theory of radioactive β-ray change. This theory shows the most profound insight into the theoretical nature of the quantum theory.

His interest in the atomic nucleus led Fermi naturally to his experimental studies in this field. Immediately after the discovery of the neutron, he realized that it provided a new possibility of attack on the nucleus and of stimulating nuclear change by neutron bombardment. This work opened up the fruitful modern field of study concerned with the transformations of nuclei of medium and great atomic number, and led directly to the most exciting transformations of all, the nuclear fission of uranium and thorium.

Prof. Fermi's work is characterized throughout by profound insight and great experimental skill. In the fields which he has made his own he is universally acclaimed a leader.

ANALYSIS AND TESTING OF COAL

THE testing of coals for their suitability in use, even after many years of effort, continues to give rise to investigation. This is due to the great economic importance of fuels, change in methods of utilization, and also to the fundamental complexity of the nature of coal. Unlike many raw materials, every coal contains several constituents, recognizably distinct, which vary in composition and character according to their origin and geological age. Moreover, they contain inorganic matter which varies widely in chemical composition and physical properties.

These complexities make the actual chemical composition of secondary importance, with the possible exception of the sulphur content. The so-called 'proximate analysis' is of prime importance as a guide to the usefulness of a coal. This involves the measurement of the quantity of combustible and of incombustible matter. Each is further subdivided —the combustible into 'fixed' carbon and volatile matter, the incombustible into 'ash' and 'moisture'. By means of these empirical tests, the observant and experienced analyst can reach useful conclusions as to the suitability or unsuitability of a coal for many purposes. Standardization of such a test is essential and more than forty years ago the American Chemical Society drew up a standard procedure. A few years later the United States Bureau of Mines made a start on this work, which has been continued in other industrial countries until a vast literature has been collected.

Dr. A. C. Fieldner, chief of Fuels and Explosives Services, U.S. Bureau of Mines, in his Melchett Lecture to the Institute of Fuel, delivered by talking film on October 13, traced the development of testing

methods in the United States. It was early found that the kind and quantity of inorganic constituents greatly influenced the serviceability of a coal. Fieldner himself was closely associated with the necessary tests. As time went on, further specialized tests have been developed—a work in which British chemists have largely participated, particularly in association with the British Standards Institution. Only recently the Institution has issued a new edition of British standard methods for the sampling and analysis of coal. It reveals a noticeable increase in the elaboration of method, even in regard to the simple 'proximate analysis'. This is doubtless due to the fact that the simplicity is more apparent than real, and the complexity of coals provides many pitfalls.

The wisdom of over-elaborating the apparatus and method of the 'proximate analysis' is open to question. There is a place—the largest place—for a test in which a crucible is heated over a Bunsen burner. If a greater precision is required, it is possible that a more precise test than that now prescribed is preferable. Time has brought more and more specialized tests designed to judge the suitability of a fuel for defined applications, for example producers, hand- or machine-fired, mechanical stokers, carbonization processes. War-time conditions have emphasized the need for these. In peace-time, coals tended to gravitate into appropriate channels, which war-time difficulties have choked or diverted. This has forced some industries to give thought to the more exact determination of their needs in order to secure that substitutes shall be really effective. All this has emphasized the importance of the subject of coal testing.

H. J. HODSMAN.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, December 5

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (in the Hotel Metropole, Leeds), at 2.30 p.m.—Dr. G. W. Scott Blair: "Some Rheological Problems in Industry".

Saturday, December 5—Sunday, December 6

ASSOCIATION OF SCIENTIFIC WORKERS (with the support of the BRITISH ASSOCIATION) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1)—Conference on "Scientists of the United Nations and the War Effort".*

Saturday

At 2.30 p.m.—"Allied Scientists" (Chairman: Sir Richard Gregory, Bart., F.R.S.).

Sunday

At 11 a.m.—"Free National and Refugee Scientists" (Chairman: Prof. John Marrack).

At 2.30 p.m.—"British Scientists" (Chairman: Sir John Russell, F.R.S.).

Monday, December 7

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. D. Jones: "Powder Metallurgy".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Dr. L. Dudley Stamp: "The Scott Report on Land Utilization in Rural Areas".

Tuesday, December 8

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. W. Norwood East: "The Differentiation, Prevention and Treatment of Anti-Social Behaviour Disorders".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. J. C. Drummond: "The History of our More Important Foods", (iii) Dairy Produce.*

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Discussion on "Lighting and Post-War Reconstruction (Guidance, Specification and Legislation)", to be opened by Mr. A. G. Higgins.

Wednesday, December 9

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. George Yeh: "The Cultural Life of Wartime China".

PHYSICAL SOCIETY (in the Cavendish Laboratory, Cambridge), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: A lecture on Newton (in celebration of the Tercentenary of Newton's Birth).

INSTITUTE OF PHYSICS (in the Lecture Theatre of the Royal Institution, Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—To celebrate the Three-hundredth Anniversary of the birth of Sir Isaac Newton. Dr. H. Lowery: "Life of Newton"; Dr. H. F. Buckley: "Some Historical Aspects of Newton's Published Works".

Thursday, December 10

INSTITUTE OF FUEL (at the Connaught Rooms, Great Queen Street, Kingsway, London, W.C.2), at 2.30 p.m.—Mr. H. E. Partridge: "Fuel Economy at Collieries".

PHARMACEUTICAL SOCIETY (at Friends House, Euston Road, London, N.W.1), at 2.30 p.m.—Dr. R. Melville: "Medicinal Indigenous Plants".

Friday, December 11

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Kahn Bahadur Sir Azizul Hugue: "Rural Self-Governing Bodies in India".

PHYSICAL SOCIETY (COLOUR GROUP) (at the Lighting Service Bureau of the E.L.M.A., 2 Savoy Hill, Strand, London, W.C.2), at 2.30 p.m.—Dr. John W. Strange: "Fluorescent Materials and their Colours"; Mr. G. T. Winch: "The Photometry and Colorimetry of Fluorescent Lamps"; Mr. H. G. Jenkins: "Commercially Useful Fluorescent Substances"; Mr. F. W. Coppin: "The Use of Fluorescent Pigments in Colour Printing".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. E. R. Davies: "The Photographic Analysis of Motion".

Saturday, December 12

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2 p.m.—Miss E. M. Blackwell: "On Germinating the Oospores of *Phytophthora cactorum*" (Presidential Address).

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, Hampstead, London, N.W.3), at 5 p.m.—Prof. M. Polanyi: "The Scientific Community".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT DAIRY BACTERIOLOGIST FOR THE LONDON AREA—The Acting Principal, The College, Wye, Ashford, Kent (December 8).

LECTURER IN BIOLOGY—The Registrar, Technical College, Sunderland, Co. Durham (December 11).

LECTURER IN PHYSICAL CHEMISTRY—The Registrar, The University, Bristol (December 12).

INSTRUCTOR IN BEEKEEPING—The Education Officer, County Hall, Wakefield (December 14).

LECTURER IN CHARGE OF MINING at the St. Helens Municipal Technical College—The Director of Education, Education Office, Cotham Street, St. Helens (December 14).

HEAD OF THE DEPARTMENT OF SCIENCE AND TECHNOLOGY, and HEAD OF THE COMMERCE DEPARTMENT, of the Southend-on-Sea Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (December 18).

HEADMASTER of the King Edward VI Grammar School—Mr. John B. Hales, Clerk to the Governors, The Close, Norwich (December 18).

ASSISTANT LECTURER AND DEMONSTRATOR IN BOTANY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (December 28).

REGIUS PROFESSOR OF GEOLOGY at Edinburgh University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (January 11).

ASSISTANT MASTER WITH GOOD QUALIFICATIONS IN MATHEMATICS AND ENGINEERING, and an ASSISTANT MASTER (OR MISTRESS) TO TAKE GEOGRAPHY AND GENERAL SCIENCE—The Principal, Technical Institute, Gravesend.

ASSISTANT (MALE OR FEMALE) TO THE PUBLIC ANALYST—The Secretary, Health Department, Grey Friars, Leicester.

VETERINARY INVESTIGATION OFFICER—The Principal, University College of Wales, Aberystwyth.

PHYSICS INSTRUCTOR in a leading Technical College in Chile—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Chile').

PHYSICS MASTER, AND A CHEMISTRY MASTER, in the Victoria College, Alexandria—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Alexandria').

RESEARCH ASSISTANT (MALE) WITH ZOOLOGICAL OR AGRICULTURAL QUALIFICATIONS TO WORK ON PEST CONTROL—Wood Pigeon Investigation, Edward Grey Institute, 39 Museum Road, Oxford.

ASSISTANT ANALYST—The Medical Director, Evans Biological Institute, Runcorn, Cheshire.

LABORATORY ATTENDANT—The Laboratory Superintendent, Department of Chemistry, Imperial College of Science and Technology, South Kensington, London, S.W.7.